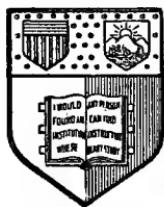


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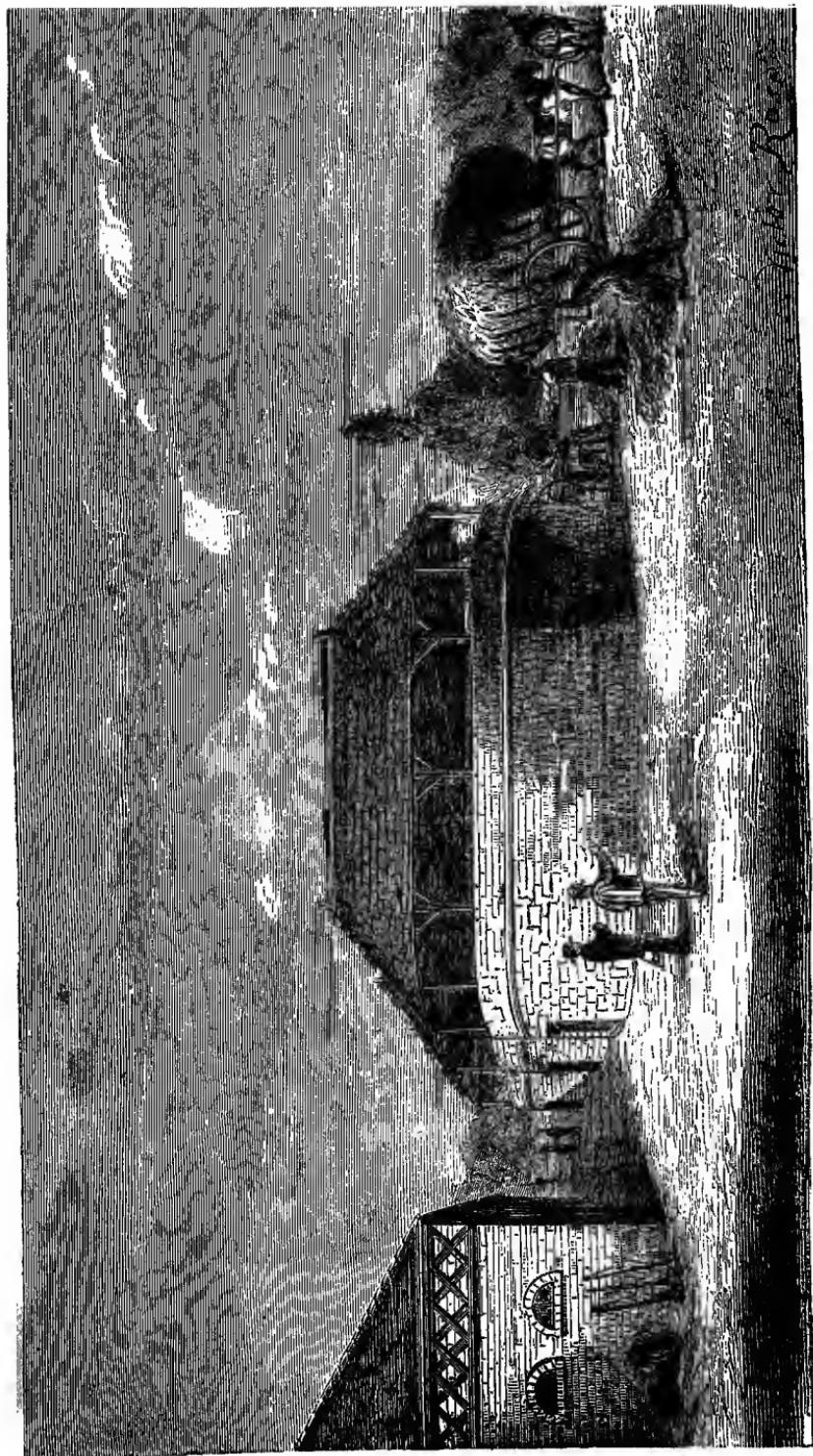
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THE INVENTOR OF THE SYSTEM OF ENSILAGE.

THE SILOS OF M. AUGUSTE GOFFART, BURTIN, FRANCE, THE INVENTOR OF THE SYSTEM OF ENSILAGE.



ENSILAGE OF GREEN CROPS,

FROM THE FRENCH OF AUGUSTE GOFFART,

WITH THE

LATEST FACTS CONNECTED WITH THIS SYSTEM.

BY

J. B. BROWN.

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CULTURE AND ENSILAGE OF MAIZE, AND OTHER GREEN FODDER.

CHAPTER I.

ADVANTAGES TO BE DERIVED FROM THE PRESERVATION OF GREEN FODDER BY ENSILAGE, OVER THE METHOD OF PRESERVATION BY DRYING.

IF there is one fact recognized by all agriculturists, it is that a certain quantity of grass, which, consumed in a green state represents an ascertained nutritive value, loses a considerable portion of that value in passing into the state of hay intended for the winter sustenance of animals.

The cow, which gives us in summer, while feeding on green grass, such excellent milk, and butter of such agreeable color and flavor, furnishes us in winter, when she eats the same grass converted into hay, an inferior quality of milk, and pale, insipid butter. What modifications has this grass undergone in changing to hay? These modifications are numerous. It is sufficient to cross a meadow at the time when the new-mown grass is undergoing desiccation in order to recognize that it is losing an enormous quantity of its substance that exhales in the air in agreeable odors, but which, if they remained in the plant, would serve as a condiment, facilitating digestion and assimilation.

All stock-raisers, those of Sologne especially, know how rapidly our young cattle increase in weight in summer on green pasture, which, converted into hay and devoted to their

nourishment in winter, scarcely keeps them in *statu quo*; hay given judiciously does not always prevent them from becoming lean.

Therefore the sole fact of desiccation accomplished by fine weather, in the best conditions, causes the loss of a considerable part of essential substance. This loss, added to the physical modifications which render mastication and digestion of the hay more difficult than of the grass, and consequently assimilation less complete, merits the most serious attention on the part of those who are interested in agricultural affairs.

The losses which I have mentioned are far from being all that result from our method of transforming grass into hay.

Rains, oftentimes prolonged, coming upon the harvest, the absence of sufficient heat in autumn, are powerful causes of deterioration of hay.

What agriculturist has not seen a hundred times his hay, injured by rain, deprived of its richest and most assimilative elements? The rain prolonged, the hay is invaded by a species of nauseous rot, which disgusts cattle and causes formidable maladies when hunger forces them to eat it. If these things occur to the common fodder crops—clover, lucern, sainfoin, etc.—what would happen to the fodder crops of high growth and great yield, such as maize and sorgho? Never in our temperate climate could we obtain for these a sufficient desiccation by the sun.

These are the grave inconveniences which from time immemorial have induced agriculturists to seek some new method of preservation for their fodder. It is nearly a century since the German, Klapmayer, called the attention of the agricultural world to his system of conversion of grass into hay, and which still bears his name—“Brown hay, Klapmayer method.” This method, which made a great noise at the time of its appearance, has had its seasons of popularity. It has been successively taken up, abandoned, again taken up; but it has in fact never been firmly implanted into agricultural

practice. For my part, at the commencement of my agricultural career, more than thirty years ago, I pursued some experiments perseveringly through two campaigns, in which I followed faithfully the directions of Klapmayer. How many times have I arisen in the middle of the night, with one of my workmen, in order to satisfy myself, thermometer in hand, that my grass, gathered in cocks larger or smaller, did not exceed the degree of heat prescribed as the extreme limit to insure excellent preservation. I never succeeded, and I doubt if any other persons have been any more fortunate.

A few years later I gave my attention to the culture of maize, and I began to seek for it a system of preservation by ensilage. I have therein entirely succeeded, but only after thousands of experiments, which have continued not less than a quarter of a century. It is that all agriculturists may profit by the experience acquired, often at my cost, upon this important subject, that I have written this Manual.

LANDS SUITABLE TO THE PRODUCTION OF MAIZE.

I DO not pretend that all soil is adapted to a profitable culture of maize. There are certain indispensable conditions of the physical, hygrometric and chemical state of the soil, the absence of which will render impossible the profitable culture of this fodder crop ; but in most instances it will answer to increase, for the first two crops, the manuring and dressing, in order to obtain a large production, which will give a sort of impetus to the new culture, and will be the point of departure of a most happy transformation. As in a machine, however well constructed, it is necessary to overcome at first the force of inertia.

NOTE.—A hectare is about $2\frac{1}{2}$ acres. A kilogramme is about $2\frac{1}{2}$ lb. avoirdupoise.

At Burtin my soil possesses some qualities very favorable for this culture, but for four years my processes left much to be desired, and within two years I have made more progress than I had obtained during twenty years preceding. The large quantity of maize that the increase of this culture and my perfected processes have placed every year at my disposal has permitted me to double the number of my stock; then each animal which formerly produced 13,000 kilogrammes of dung has produced, since it has been better nourished, nearly 20,000 kilogrammes. Therefore, if my maize requires abundant manuring it causes a production of manure more than sufficient. In fact, a hectare of maize, properly treated and successfully preserved, yields a product of more than 50,000 kilogrammes of manure, and absorbs hardly one-third of this quantity. It is necessary to add that each week I spread upon my dung-heaps 100 kilogrammes of phosphate. This practice gives excellent results, above all in Sologne, where our soil, naturally very poor in phosphoric acid, requires that we should furnish it in every possible form. Some foreboding people predicted four years ago that I would lose all my stock if I continued to feed them exclusively on maize throughout the year. I have continued to do so, and all my animals enjoy excellent health, without even a shadow of a malady. One of the most valuable properties of maize is the power of self succession almost indefinite. Some of my finest maize occupies a field which, during the past eighteen years, has borne fourteen harvests of that plant without giving any signs of weariness; on the contrary, the later yield is better than the former. All the requirement is to give to the land suitable manuring, restoring each year the equivalent of that which is taken off. Potash is the predominating component of maize. Animals consuming it assimilate very little potash, and the dung-heap restores to the soil nearly all of it that has been removed in the crop. Another plant, much cultivated in Sologne, the hemp, possesses also the property of eternalizing

itself upon the same field. Each farm has its hemp field, which, for centuries, occupies the same ground.

The soil which is best adapted to the culture of maize is of medium consistency, rather light than heavy, moist without being wet, rich in alluvial matter, and therefore of a dark color. It is remarkable that our poor Sologne possesses an abundance of this kind of land, as if Heaven had wished to give it some sort of compensation for all its other inferiorities. Heavy soil is equally well adapted to produce very fine maize, but requires more labor; for it is necessary to bring it to a state of fine pulverization, at the risk of the seed not sprouting, which is always difficult in compact earth. In general terms, maize will succeed wherever beets do well, with the same conditions as to manuring and top-dressing. But maize cannot, of course, have the pretension to compete with advantage against such a rival; above all, in the rich countries where for so long a time it has been cultivated as a plant that is both valuable in commerce (sugar) and for fodder. In those parts maize can only make for itself a modest place, as a means of varying a little the food of our animals.

But in those countries, such as the South of France and Algeria, where the excessive heat causes the beet to fail, there maize will render immense service. Preserved by ensilage, it will assure at all times to the cattle sufficient food, instead of those alternations of abundance and scarcity which often have such sorrowful results.

METHODS OF CULTURE.

FORMERLY I planted my maize in ridges, which has been the sole method practiced for a long time in the fields of our Sologne. The ridge in shallow soil but little dug up is an excellent method for protecting the fall seeding against the wet, so destructive in winter. But as a spring crop it is necessary to give up the ridges entirely, and to replace them by beds more or less extensive. These, by yielding less evaporation, provide better than the ridge against the dryness of summer. Another motive, more serious, pleads also in favor of beds. When well compressed by a heavy roller, they protect the seed, more effectually than the ridge, against one of the most to be dreaded plagues of this culture. At the moment when the little shoot makes its appearance out of the earth, the birds come in crowds, in order to pull up and eat the grain which adheres to and comes out of the soil with it, especially when the soil is light, as it commonly is in Sologne. I have lost several times a third, and sometimes a half, of my maize, devoured thus at the birth, by crows, pies, and pigeons, which swarm in our fields. A good rolling of my beds with a heavy stone roller is an effective preservative against the danger which I have mentioned. When the earth has been well packed down by the roller, the bird that pulls up the shoot of maize finds that it breaks off near the ground without being followed by the grain, which is all that has any value to him. Deceived in his hope, the bird gives up very quickly an ungrateful labor which refuses him the reward upon which he had reckoned. Besides this, the roller is an instrument of security for our light soil. It strengthens the hold of the plant upon the soil, and it has saved, twenty times, my crops that were in danger by being laid bare.

The use of the seeding machine is the surest and least

NOTE.—For Iron Rollers, see List.

costly method. It economizes the seed, which often costs so dear, and it gives regular and equal lines, which render the after cultivation very easy. For want of a machine, I have obtained very good results in distributing the seed by hand, by women, who follow the laborer and only put the seed in every second furrow. I obtained thus wider rows, but regularly spaced and easily cultivated.

NOTE.—The translator supposes that the gang-plow is used in this case. The French plow of this kind excelled even our American plows at the Paris Exposition, and is to be introduced into this country. The remainder of this chapter is devoted to comparison between drilled and broadcast sowing, which is omitted as valueless to the American farmer. The mechanical genius of the United States and Canada, fostered by the Patent Office and rewarded by the immense demand for its results, has settled this question to the great relief of the arms and backs of the laborers.

YIELD OF MAIZE.

THANKS to the care that I have specified, I obtain from my maize an enormous yield. In the past five years the minimum has been 75,000 kilogrammes per hectare, and the maximum 415,000. The average yield has been 90,000 kilogrammes per hectare.

NOTE.—About 40 tons to the acre.

FOOD VALUE OF MAIZE.

IT is only by experience that we can solve the question of the alimentary value of maize. I can assert, however, that at my home at Burtin, in the way in which I prepare it, maize with one-tenth of its weight of oat straw maintains my

animals in perfect condition. It would be, I confess, going too far to say that maize alone has the faculty of making very fat animals for fairs, or for high quality butcher stalls. Cows which are not being milked quickly take a condition entirely satisfactory to our country butchers, who are, as a class, less exacting than those of the city. But for perfect fattening it is necessary to add other aliments to the regular ration, such as beet-pulp. I have tried the experiment of fattening five animals with my preserved maize, and an addition in the commencement of four kilogrammes per day of oilcake. They became fat with surprising rapidity. At this time seventy-three horned animals live only upon maize and straw on my farms at Burtin and Gouillon, and my stables are always open to visiting farmers. Maize poorly preserved is a poor nutriment for animals, and may even become a poison for them. We should not lose sight of the fact that in the condition of the preserved fodder there are an infinite number of degrees to which the nutritive value corresponds; the method of cutting, the chemical modifications to which it is subjected, cause it to vary from single to double the nutritive power.

Says one person to me, "I can use but one-half maize in my rations; otherwise my beasts would perish." Another says, "One-third is the maximum quantity that my beasts can stand in their rations." Another pretends that a quarter is hardly durable. Gentlemen, only make good ensilages, and all will change with you, as it did with me. The ensilages of my first attempts were no better than yours. Little by little I have made them better, and therefore better supported my animals—that is the whole question. My much regretted relative, Louis Pilat, who held for many years the first rank in the art of fattening sheep, when pressed by me to divulge his secret, replied, "My secret: I have none; it is only a question of fare. Induce the animals to eat abundantly by a large choice, variety, and good preparation of food; that is all there is to it."

Now is maize by itself a rich food? Evidently not. Without the analyses more or less exact that have been published, one fact proves its lack of richness in nutritive principles, and that is the large quantity that animals eat in order to keep them in good condition. This fact I have recognized and published twenty times. No one would pretend that a kilogramme of maize could be made to take the place of a kilogramme of lucern, clover, or French grass (*sainfoin*); but by supplying in quantity what it lacks in richness, we can maintain our animals by maize as well as by the richest grasses. The question is to compare the selling value, or rather the price that returns from the two kinds of fodder, and to ascertain if twice the quantity, or even thrice, does not cost less than the products that it replaces. To me, the affirmative is not in doubt. The question is simpler when we apply it to countries, too numerous indeed, which, like Sologne, produce good crops of maize, but are rebellious to the culture of rich fodder, lucern, *sainfoin*, etc. In such places the cultivator has no choice; he has only to avail himself of the benefits of maize, and he is spared all embarrassment. One important point that a long practice has put for me beyond doubt is that the same green maize taken nourishes better, the weight being equal, when it is cut short than when it is fed whole, and that its nutritive power increases when it has been softened by lying several weeks in a silo, then undergoing a light commencement of alcoholic fermentation a few hours before being fed out. I estimate that with young animals acclimated, the increase of weight at eighty centimes per kilogramme (7 cents per lb.) will pay upon an average about 20 francs per thousand kilogrammes of preserved maize (about \$3.50 per ton). I consider this price as so nearly regular that I adopt it as a point of departure when I wish to reckon up my farming operations.

Fattening by means of preserved maize, with an addition of cake of arachide (*earth-nuts*) has given me excellent results. I have fattened this winter eight animals from my stables

which I wished to part with on account of old age, sterility, deformity, under size, or mischievous disposition. Their value on foot before fattening was 55 centimes per kilogramme. They sold for 70 centimes per kilogramme; there was an increase of weight of 447 kilogrammes, and in value 845 francs 25 centimes. These animals consumed during their fattening, averaging 58 days, 2935 kilogrammes of oilcake, costing 10 centimes per kilogramme, or a total of 293 francs 50 centimes. The maize therefore paid me about 45 francs per 1,000 kilogrammes, which is indeed a high price, better than one could obtain either by milk, the increase of young animals, or other products of the stables. Preserved maize has also the merit of exciting to its highest point the appetite for oilcake, which is at first repugnant, especially at the commencement, if it is fed alone, without being mixed with maize, which has so much attraction for them. A third experience, viz., the nutritive value of maize in view of the raising of sucking calves, resulted in paying me 40 francs per 1,000 kilogrammes of maize.

Numerous experiments will be necessary in order to settle these questions. I have wished simply to indicate them and to put them in some sort of order before recommencing them. The advantages that I have enumerated are not the only ones that belong to this culture. These plants have large and numerous leaves which exercise a happy influence upon the health of the country where they are cultivated.

They absorb miasms which arise from the earth at the critical moment in certain countries where the crops of grain and fodder have just been removed. The maize in full vegetation at that moment replaces, as an absorbent, the other vegetation. Planted in gardens near habitations they play at first a hygienic role; then gathered and dried, if need be near the hearth, and the stalks cut in pieces of eight to ten centimetres long, placed in a close vessel filled with warm water, they quickly produce an agreeable drink much appreciated by workingmen.

PROCESSES BY WHICH I HAVE SUCCEEDED IN ASSURING
THE PRESERVATION OF GREEN MAIZE FOR AN INDE-
FINITE TIME.

THE end to be attained is to prevent all kinds of fermentation before and after ensilage; for the way to avoid bad fermentation is to not permit any. It is by not having discovered sooner this fundamental principle that so many seekers like myself have lost so many years in barren experiences. We wished to preserve maize by fermentation; that is to say, we turned our backs on the solution of the problem. Fermentation preserves nothing. On the contrary, it is always a preliminary step towards a decomposition more or less putrid, towards a real destruction. I have had this experience a thousand times: when my maize had contracted in my imperfect silos alcoholic fermentation, I hastened to have it eaten up as soon as possible rather than to see it pass to acetic fermentation, and soon after to lactic or putrid fermentation. These experiences, so often repeated and always fruitless, had finally discouraged me. For a long time I had resigned myself to only require from my silos a temporary preservation of a few weeks at the most; that is to say, the time that lapsed between the ensilage and the appearance of putrid fermentation. I had, however, from that time, at my disposal all the elements

of a complete success. In 1853 I had established at Burtin a complete factory for preserving—a powerful feed-cutter from England, which has admirably performed for me, for more than twenty years; a hydraulic power, eight-horse, to work the feed-cutter; then at two steps from the feed-cutter, four silos, hollowed in the ground, plastered with Portland cement, and perfectly water-tight. I cut at that time my maize in pieces of three to four centimetres long; I mixed a certain proportion of short straw (always too much), and I filled successively my silos by pressing down the layers of the mixture by one, and sometimes several persons treading upon it. After this pressing down with great pains, I placed on the top a layer of short straw about ten centimetres long, and above all a layer of loam, beaten with care, in order to prevent all contact between the ensilaged maize and the air outside. During the following days I stopped up the fissures which appeared on the surface. When I proceeded, several weeks later, to open the silo, I found invariably a vacuum of several centimetres between the maize and the superincumbent clay. Notwithstanding the force of the compression that was produced during the ensilage, the maize had undergone another settling, and its upper part presented an alteration which would communicate rapidly to the lower layers. In order to avoid this result I had no other means than to feed it out as quickly as possible. Later I abandoned the clay as a covering for my silos. Immediately after having pressed in my mixture of cut maize and straw, I applied above all a covering of plank fitting exactly the opening of the silo, and descending with the maize as it shrunk down. This simple change produced a perceptible amendment, but it was quite insufficient still. The alteration was but little retarded, but I was on the right track. To-day I still use the same silos, and I obtain a preservation indefinite and complete. In what then have I modified my processes? Instead of cutting my maize in pieces of three or four centimetres in length, I cut them one centimetre only. Instead of

mixing a quarter and sometimes a third in weight of short straw, I never exceed the proportion of one-tenth, and oftener I bury the maize without any mixture. Finally, and here is the principal difference: I pile on the cover of my silo when it is filled, four or five hundred kilogrammes of stones or blocks of wood per square metre of surface. By my first processes I obtained only a temporary and incomplete preservation; with my last I obtained a preservation indefinite and absolute. How have these three simple modifications led to such marvellous results? To explain this will be the object of the following chapters.

NOTE.—A centimetre is about $\frac{1}{10}$ inch.

HOW THE MAIZE SHOULD BE CUT.

AGRICULTURE does not generally appreciate at its full value the advantages that can be derived from the cutting of fodder as affecting the nourishment of cattle. Even besides the preparation for ensilage, these advantages are considerable. The feed-cutter with its cutting-knives and the fluted cylinders which precede them, and which act in some sort as molars, work certainly better and more economically than the jaws of our animals, especially when it is moved by water, by steam, or by horse-power. (I do not speak of the arms of men, which have become too scarce, and therefore too dear for that service.) The labor of mastication is an expenditure of force which the animal does not perform gratuitously. I leave to our skillful professors of mechanics the care of determining scientifically the effort that animals make in grinding the different food that is presented, and which proportionately requires an addition to its ration in order to represent that ex-

penditure. I have seen in former times in my stables, when I caused my beasts to eat maize uncut, that they were fatigued by their incessant efforts to tear to pieces the large stalks, and were so exhausted as to fail to profit as they have done since by this excellent food when presented in a form more favorable for its absorption. Imagine two men obliged to support themselves, one upon the wheat in grain, and the other upon the same quantity reduced to flour. You may be sure that these two men would not profit equally from their respective food, which, however, is chemically the same. The same maize produces food very different in its effect, according to whether it has been only cut, or cut and softened by the commencement of fermentation, or offered to the animals in whole stalks more or less dry. The fineness to which I cut my maize at the moment of ensilation is extremely important in view of good preservation. Cut in disks of only one centimetre thick, the maize packs better in the silo, it occupies less space, and takes the form and consistency of a species of pulp, leaving in its mass the least possible amount of air. In proportion as the length is increased, the preservation becomes less perfect, and finishes by being entirely defective. Last year a cultivator of the valley of the Loire, took from me the dimensions of my elliptic silo, and reproduced it exactly on his own farm. He filled it in the autumn, and when he opened it during the winter, he took out a poorly preserved product, which his beasts only eat with repugnance. Greatly disappointed, he brought to me a sample of his maize that he had cut in lengths of five to six centimetres, instead of one or two at most, as I had advised him. I recognized at once the cause of his failure, and asked him why, contrary to my advice, he had cut it so long. He replied, "I was not able to procure a steam engine which I expected to use, and I had to use a horse-power; the work did not get along fast enough, and in order to hasten it, I decided to cut it in such long pieces." He was surprised at the excellent preservation of the maize at

Burtin, and he carried home a hundred kilogrammes ; his cattle were thus enabled to appreciate the difference. I cite this fact because it contains a valuable lesson.

PROPER PROPORTION OF STRAW.

At the beginning of my ensilages I had as principal resource for the sustenance of my stock a great quantity of wheat, oat, and rye straw, etc. In order to induce my cattle to eat it, I mixed all that I could with my maize and my green cut rye, but I was not slow to notice that this mixture kept much less time as the proportion of straw was greater. A fiftieth in volume, or a tenth in weight, was the maximum of what the maize could carry without being exposed to an early alteration ; when I increased this quantity, the time that it kept always diminished, and at last did not exceed forty-eight hours. I attribute this to the fact that the straw, being very dry, absorbs from the maize too much of its water. The moist condition of the ensilages, instead of being a cause of deterioration, is, on the contrary, to a certain extent, indispensable to the good preservation of the whole matter.

Maize in its normal condition contains about eighty-five per cent. of water ; when the addition of dry straw has caused the mixture to decline to an average holding less than seventy-five per cent. the good preservation is much compromised, and quickly becomes impossible if we try to go below it. Besides the too great dehydratation that the presence of the straw may cause, it also offers another serious inconvenience, especially rye straw. This straw when cut forms a great quantity of little tubes, the envelopes of which resist decomposition for a long time ; these tubes inclose an apprecia-

ble quantity of air, which is the most dangerous enemy of ensilage. Oat straw, or others of softer texture, are less dangerous in this respect than rye straw. While I used at first the short straw from my threshing, always troublesome on account of the amount of room that it occupies, henceforth I shall bury my fodder almost without any mixture. Sometimes, however, it is well to mix short straw with maize without passing suitable limits. Such a case presented itself at Burtin, in the autumn of 1876. When maize has been cut before the frost, and arrives in good condition to the cutting-machine and then to the silo, it does not yield its water easily, even when it is submitted to a considerable pressure. But it is not the same when this fodder is too old, and has been exposed to the rains and frosts at the end of autumn.

On one occasion, in October, 1876, I found, for lack of sufficient silos, that it was impossible to bury all my crop of maize. I was obliged to improvise a new silo, in an old building, in order to place the surplus, and this ensilage was not completed until the first days of December.

The stalks, touched by frost, had become very soft and weak. The cutting was difficult, but, most unfortunate of all, the layer of cut maize had scarcely attained in the silo two metres of thickness, when, by reason of the pressure upon the first layer, the juice began to run out freely through the opening, and this discharge continued for several days. This was a serious loss, which I could have avoided by mixing some cut straw with the overripe maize. Except in this case, my maize has never lost in this way any of its water; at the disinterment the bottoms of my silos have always been found nearly dry, barely moist.

COMPRESSION OF THE SILOS.

It is indispensable to superimpose four or five hundred kilogrammes per square metre of heavy materials upon the covering or movable planks of the filled silos. I meet here the most important question—that which I have had the most trouble to solve, and which I have only really solved quite recently. When a silo has been filled, it does not answer only to prevent the external air from penetrating it; it is necessary at once to seek means for expelling the mass of air that it incloses between its disks and in its cells. It is here that the heavy materials with which I load my silos become important; it is necessary that the air inclosed in the silo should find between the joints of the covering planks an outlet; it is necessary that a strong compression should compel this air to pass out quickly and to quit the place where it would cause most serious damage if it remained. It is necessary that this powerful compression should continue during several months, because the tramping of the workmen is insufficient, for the following reasons: At the moment when the green maize is cut, it is all alive, and is so elastic that it reacts forcibly against the momentary pressure of the feet of the workmen. It is not the same several days or weeks thereafter, but its elasticity diminishes, or, in other words, its compressibility increases in considerable proportions; it is then that the heavy superimposed materials follow the maize down in its softened condition, continuing to press it in proportion as its compactness increases, and brings it to that state of density that is necessary in order to put it out of reach of all alteration.

NOTE.—A metre is about 3 feet $3\frac{1}{3}$ inches.

THE PROPER HYDROMETRIC CONDITION OF MAIZE AT THE TIME OF ENSILAGE.

A FAULT which I often committed at the commencement of my experiments, was to leave my maize upon the field in order that it might undergo a partial desiccation before the ensilage. This is to be avoided absolutely. When the water evaporates from the cells of the maize, it is immediately replaced by air; that is to say, by the most active agent in all alteration. Let the maize keep all its water, if you wish to preserve it by ensilage.

All the directions which I have laid down as proper for the ensilage of maize, apply to all other fodder without distinction, and insure the same success. If I speak more particularly of maize, it is because I have found in that wonderful plant all the elements of a new and boundless agricultural wealth, from the day when I arrived at the assurance of its indefinite preservation by ensilage for the nourishment of my cattle throughout the whole year. Before this time it had hardly nourished them during three months, while it was possible to feed it to them green.

EFFECTS OF ENSILAGE UPON FODDER.

My maize, my green rye, my fodder of all kinds, have scarcely changed color, after eight or ten months of ensilage; fed exclusively to my animals, they produce exactly the same effects, the same abundance of milk and butter, the same flavor, and the same color to the butter. These qualities, so important to

butter preserved through the winter by the ensilage, are in my eyes the true touchstone, when we seek to appreciate the respective merits of the different processes of preservation of fodder. Let a farmer show me the butter that his ensilage gives him during the winter, and I will have no need of other means of investigation in order to arrive at his skill. "A workman is known by his work."

I opened in April, 1877, my last elliptic silo, which contained nearly 100,000 kilogrammes of maize, ensilaged in October, 1876, more than seven months. It disclosed a very compact mass of a brownish green color; the temperature did not exceed 10 degrees (Réamur); there was no appreciable odor; taken in the mouth it was really insipid, and this freedom from odor and taste produced at first an almost disagreeable sensation.

I detached from the mass several hundred kilogrammes, intended for the next feeding of my animals. It was hardly exposed to the air when it underwent a veritable change: the brownish color became sensibly green, the beginning of alcoholic fermentation took place, without exceeding the limits which that fermentation ought never to pass. That silo was not completely exhausted until the 10th of August, and the maize remained in good condition until the last day. My forty-days maize reached at that time the point where it was suitable to be cut for fodder; it had attained its full height, and in the month of August my animals eat it green; they were only ten days without maize during the year 1877.

My silos of rye will be consumed during the winter. I do not need to say that green rye is much richer than maize, and a much smaller quantity will go as far; the mixture of these two kinds of fodder is an excellent diet.

My animals, fed upon maize ensilage during the whole winter, scarcely drink when they are loosened in the middle of day to quench their thirst at the river which crosses my farm; nearly all return to the stable without having approached it.

Their excrements, of medium consistency, denote a very favorable pathological condition. We must conclude that maize ensilage in the matter of retaining water is a well balanced food, since it furnishes to animals, in most suitable proportion, food and drink. Each one of my ensilages may be regarded as an immense cylinder, and its covering of plank, a gigantic piston, whose surface exceeds fifty square metres ; the heavy substances which I superimpose act as a motive power, causing the piston to descend and compress the ensilage, leaving between the planks an outlet for the air, which the compression is intended to drive out. My large operations I have frequently repeated in a small way, with a glass jar 27 centimetres in diameter and 50 centimetres in height; a wooden disk, surmounted with a faucet, furnished with a rubber tube, acts as a piston ; I load it with a certain ascertained weight in order to compress the matter in the jar ; a second faucet is put in the bottom, when the pressure commences to lower the piston. The air in the ensilage escapes by the two faucets, and I easily ascertain the quantity. In the beginning the faucets give out pure air, the volume of which is exactly equal to that the mass has lost; afterward, if the compression has been insufficient and has left a certain amount of air in the mass, it is no longer pure air which comes out when I open the faucets ; there have been some very interesting modifications produced in the mass, interesting to follow and well worth the study of the chemist.

“But,” as has been kindly said to me, “you are making sour-kraut; that was made long before you did it.” If I am making sour-kraut, or anything resembling it, I make it without cabbage and without pickle, with different kinds of fodder, and my sour-kraut cost but $\frac{1}{2}$ centime a kilogramme ; it is sour-kraut for animals, who show themselves very grateful for it. This sour-kraut is a complete agricultural revolution.

HOW TO BUILD A SILO.

WITH my new stables at Burtin finished, I shall be able to house one hundred horned cattle. My ensilages of 1877 only permit me to feed seventy, but with those of 1878 I expect to be able to feed one hundred. I have just finished three united silos, which form a part of the plan of my new stable.

The form of the silo exercises a great influence upon the results. It should avoid all angles, and should offer the least possible resistance to the packing down of the ensilage. The elliptic silo with vertical walls is the best form both for use and for durability. It is important to have them as large as possible compatible with the conditions of easy and economical use. The preservation of the ensilage in small silos is always less perfect than in large ones. No matter how much care is used and how much weight is applied, I have always found the portion which is farthest from the walls to be the best preserved, and that close to the walls there is always some alteration, not serious, but which it is important to reduce as much as possible. Small receptacles offer proportionally much more surface for contact. A rectangular silo, for example, of one metre each way, containing one cubic metre, presents five square metres of contact surface, while one of ten cubic metres, with 1,000 cubic metres of contents, presents only 500 square metres of contact surface, diminishing nine-tenths the evil indicated. But I do not advise silos of such dimensions as this. At the commencement of my experiments I recommended small silos, in order that when opened they might be quickly consumed before they became a prey to the slow combustion which the contact with the air produced, with as small an entrance as possible for the air, of which the first effect was to raise the temperature, and then produce fer-

mentation, first alcoholic, next acetic, and then putrid. But the day that I discovered the new process of a movable weighted covering, so that I was able to maintain in the mass a continuous density whereby the penetration of the air became impossible, I abandoned the small silos. Since then I have made them as large as possible, and they are only limited by the economy of the different operations of ensilage.

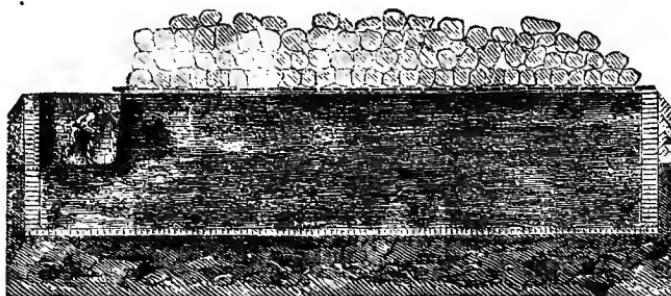
HOW TO FILL A SILO.

It is necessary to procure, either by purchase or rental, a motive power and a powerful feed-cutter. Large farms are generally provided with these machines, but the average farmer will have to hire. It may be that the travelling contractors for threshing will become contractors for cutting maize for ensilage, with a machine that possesses sufficient weight to be solid, and is also portable. Filling the silo should be done as rapidly as possible, and the layer of maize should be kept level all the time. The greater the compression the better will be the preservation. The packing along the walls (which should be as smooth as possible) should be attended to carefully. A woman turning continually as near as possible to the walls will accomplish this very well.

When the silo is filled to the top and carefully leveled, spread along the surface short straw four or five centimetres thick, then place on top of this boards fitting close together. These should be put across the silo in order that when it is being fed out they may be taken off one by one, as the silo is cut down vertically. Upon this flooring there should be piled abundance of weight, such as stones, bricks, logs of wood, or old bags filled with dirt, etc. At Burtin I have aban-

doned using loose earth as a means of compression, as it infiltrates into the ensilage, and adhering to the walls a vacuum forms as the maize settles away, which is destructive.

NOTE.—The translator lost his first investment in ensilage by depending upon earth covering, which arched by freezing and left a vacuum.



A filled Silo being emptied by vertical slicing.

Any ridge on the silos is objectionable, as the ensilage cannot be sufficiently compressed, and the dry rot soon attacks it and communicates to the material below.

As to using salt in the silos, it is not very important, and I often omit it without any bad result; but I believe the moderate use of salt is favorable to the health of animals, and I sometimes mix in my ensilage one kilogramme to a cubic metre of maize, the average weight of which, after being packed, is 812 kilogrammes.

When the ensilage is fed out it should be exposed to the air fifteen or twenty hours, in order that the alcoholic fermentation may commence. The proper time depends upon the temperature, but if kept longer than this, the fermentation becomes excessive and injurious. The spontaneous heat which is produced in the feed should never exceed 35 or 40 degrees (R.). Two years ago I had no silos at my farm at Gouillon, and I carried every other day from Burtin what was necessary. From the second day the heat exceeded these limits, and the alcoholic vapor abundantly emitted indicated the seri-

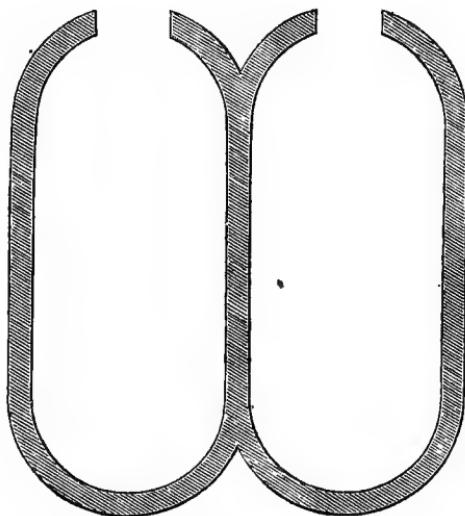
ous loss that was going on. The acetic acid was not slow to join the party. In the north, the beet pulp that is fed in winter is nearly always quite sour; it is to this circumstance that I attribute the poor quality of milk and butter obtained from the animals kept on this food.

THE NEW STABLES AT BURTIN, AND THEIR SILOS.

My new stables are a square of twenty-four metres on each side, divided into two compartments, each of which has a central passage between two rows of stalls. These passages are connected with the silos by a small railway, which makes it convenient to bring the feed before each animal. The maize and the other ensilaged fodder is carried in willow baskets all of the same size, which are frequently weighed in order to keep account of the weight of the rations given to each lot of cattle. My silos are elliptic in form, with perpendicular walls as smooth as possible inside, five metres wide and the same height. Should I modify them in any way in future it will be only to increase the height.

My farm at Burtin presents exceptional difficulties for building silos. Everywhere the water is met at one metre below the surface, and as I want to sink my silos nearly two metres, because the part below the ground preserves in summer more moisture than that part above the ground, I am obliged to first dig a ditch lower than the excavation all around it, and then to cement the lower part, which causes a considerable expense. I put concrete on the bottom, and upon this I build the vertical walls of the thickness of two bricks (45 centimetres) to the top of the ground. Above the ground I reduce the thickness to one brick and a half (about 34 centi-

metres.) I coat the walls with Portland cement sufficient to insure their perfect impermeability. My triple silos have cost me 4176 francs, and their total capacity 812.45 cubic metres, about 5 francs 14 centimes per cubic metre. I intend next year to raise the walls of my silos another metre, so that their capacity will be about a thousand cubic metres. I postpone till that time my decision as to a special cover for them.



Plan of united Silos.

Most agriculturists are more favored in the profile of their soil; many of them have a hillside in the neighborhood of their barn, in which they can open silos that will always be dry, and in some places can dispense with masonry by having solid rock. Those who wish to imitate me will have less hesitation when they know that Burtin is a particularly bad place for building silos, and that they can obtain the same results with much less outlay.

In making use of such large silos as these it is necessary of course to have a cutting-machine with a six-horse power engine at least, and an elevator to raise the cut fodder over

the walls of the silos. I estimate that with these instruments one silo can be filled in three days at most without difficulty. This rapidity is necessary in order to assure the success of ensilage. When the elevator and cutter are combined in the same machine, the process will be simplified.

As to the average farmer, as I have already said, it will be better to employ the threshing-machine contractors, who will find it to their interest to adapt themselves to this business also. It is above all the duty of the wealthy agriculturists who have entered upon the way that I have indicated, and from whom I receive every day so many grateful letters, to assist the willing farmers around them, and who have need of their advice. For my part, I shall hold myself in the future as in the past always at the disposal of farmers who think they need to recur to my experience.

I engage to pay a prize of 500 francs to the first threshing-machine contractor who will prove to me that he has ensilaged in this way at least 2,000,000 kilogrammes of fodder.

EFFECTS OF FROST IN SEPTEMBER, 1877, AT BURTIN.

I had hardly finished this little work when I was surprised, as were all my confrères, by a meteorological circumstance that was exceedingly injurious. A heavy frost in the nights of the 22d and 23d of September and following, stopped short the vegetation of my maize, which at the bottom of my valley had the appearance of having been burned down to the roots. My maize on higher ground suffered less, but the growth is also stopped, and the crop will be much smaller. When such a misfortune occurs, the most effective way to lessen it is to cut the maize and proceed with the ensilage immediately. Thanks to the prompt measures taken, the frost caused me little other damage than a diminution of the crop, according as it had more or less attained its full development. The maximum height of my stalks was 4.72 metres, and from that down to 3 metres.

HISTORY OF M. GOFFART'S INVENTION.

From his Speech at Blois, May 8, 1875.

IN 1850 I made some experiments in the ensilage of wheat at Versailles, since which time the preservation of fodder has become my favorite occupation. In 1852 I constructed four underground silos, with masonry, and cemented, each having a capacity of two cubic metres; these silos I have filled and emptied several thousand times. Maize, Jerusalem artichokes, beets, sorgho, turnips, potatoes, straw, I have experimented upon with more or less success. Straw, in the scarcity of fodder, has several times saved my stables. Some years ago I had in the autumn more than 80 horned cattle, and my hay crop would not have permitted me to support 10. One should be an agriculturist of Sologne to know what such a trouble means. In rich countries when the hay crop fails, it means that instead of harvesting 5,000 or 6,000 kilogrammes to the hectare, there are only 3,000 or 4,000, but in Sologne it means that there is no crop at all. In such difficulties the enterprising cultivator must use more intelligence and more industry. "What the man is worth, that the land is worth," is an old proverb, but I will improve upon it by saying, the man should be worth more, as the land is worth less.

I got through safely that year by having 50,000 bundles of wheat, rye, and oat straw. I cut them up, and with 35 kilogrammes of rye flour, which I fermented each day in large tubs, and in which I soaked the straw, I obtained food that was softened by fermentation, which my cattle ate freely and digested easily. Thus I reached the following spring without being obliged to sell my cattle at a low price. I must acknowledge that at the end of winter my beasts were in a sorry condition, but the first grass quickly restored them, and I was not compelled to replace them at a high price in the spring;

and now, the two years of scarcity which my fellow-agriculturists have passed through have been for me—owing to my silos—years of unprecedented plenty. What I have done can be done by thousands of others, and my earnest desire, my sole ambition, is to enable them to imitate me as soon as possible. Until 1872 I only expected from my limited ensilages the means of prolonging for three weeks, or at most a month, the use of maize, so desirable a food for my cattle. To that end I made many experiments. I have mixed my cut maize with various proportions of straw, in order to find which would give the best result. I have made silos without cover, burying the ensilage under bundles of straw, then with earth (never sand). I have filled my four silos with every possible mixture, which would sooner have put me upon the road to a positive success if I had not been too easily alarmed by slight alterations on the surface, and which I caused to extend all through by too frequent examinations.

In 1873 I had a real success, due mainly to accident; and it is to be recognized that chance nearly always plays an important part in the happiest discoveries.

Until this time I had hardly believed that the preservation of green maize for a long time was possible, and I had very little confidence. I hesitated a while, and should have probably hesitated a good while longer if I had not been in a measure compelled to do something. The year 1873 had been exceptionally favorable for the culture of maize. At Burtin the crop was enormous. After having fed my cattle abundantly until October, besides having all that they could eat while green till December, I found that I had more than 170,000 kilogrammes that would be lost if I could not keep it at least till the following March. I went resolutely to work, and I have described elsewhere the means that I used and the result that I obtained. The difficulties were greater than one would believe, on account of the lack of faith of my employees. One day I had to leave my workmen for a while, but my return was sooner than they

expected. The work had ceased, of course. They were talking together, and I overheard my foreman say to the workmen, "This work that we are doing is all foolishness ; M. Goffart had better throw his maize into the dung-heap at once, because that is where it will go to at last." I said nothing, but redoubled my watchfulness, knowing how little zeal I could expect from people so convinced of the uselessness of their labor.

A silo built upon the ground gives the best result during the cold season from December to March, but as the temperature rises fermentation develops rapidly. The underground silo with masonry walls is better ; the temperature does not rise even in April, and at Burtin at this time (May 8) it is nearly in the same condition as at the time of ensilage, seven months ago. I would advise that the silo be sunk two metres in the ground, with masonry walls, and raised two meters above the ground. During the cold weather I would feed out the ensilage in the upper half, and reserve for the warmer months the lower half.

The experiment of an underground silo, but without facing the walls with masonry, has also given a favorable result, in the sense that the loss has only been one per cent of the whole, but such a silo soon falls down when it is empty, and consequently is much inferior to the former. There is another method, the simplicity of which is a dangerous temptation to the inexperienced. That is to pile the cut maize upon the soil, and to cover it with a layer of earth. I can assert that such a silo has never given good results. The packing down, which is essential to good preservation, cannot be applied to such a silo. Those who recommend this method of ensilage manifest a culpable ignorance, and cause great loss to those who follow their advice. When one loses half his capital in an operation, he is not successful ; he makes a disastrous speculation. I proscribe this method in the most positive manner.

I once buried, for experiment, a thousand kilogrammes of corn-stalks, uncut, under a stack of straw, forming a layer 25 centimetres thick. In eight days it went to the dung-heap. .

The cost of gathering and ensilaging 226,000 kilogrammes of maize has been as follows:

	Francs.
57 days of men, at 2 francs.....	114.00
9 days of women, at 1 franc 10 centimes.....	9.90
5 days of 2 drivers and 4 horses, at 16 francs.....	80.00
5 days of engine, from contractor, at 10 francs.....	50.00
Old wood for engine, 3 francs per day.....	15.00
Total.....	268.90

Making cost of 1 franc 18 centimes per 1,000 kilogrammes (about 20 cents per gross ton). About 40 per cent of this expense was for the cutting and putting in the silos.

We should not lose sight of the fact that the crushing of the food saved to the cattle by the cutting is in itself an important saving of food.

It is above all important to avoid all kinds of fermentation during and after ensilage. Fermentation can be produced whenever desired, and a few hours suffice to give all its useful effects. Take each evening from your silo the maize required for the next day's feeding, and 15 or 16 hours after, however cold and free from fermentation when taken out, it will be quite warm, and in full fermentation, and the animals will eat it greedily. Eight hours later it will have passed the proper limits, and it will rapidly spoil.

This first fermentation increases the facility of digestion, and therefore the nutritive or assimilative power of the food. For instance, when cattle live on fresh maize in the summer, they eat large quantities, and are always big-bellied, which shows that they are obliged to supply what is lacking in quality by an excessive consumption; but when they live on ensilaged maize which has fermented, their bellies are smaller, they eat less, and their whole condition is more satisfactory. To study all things, to try all things, to be always willing to change the system when one finds himself in the wrong—

such is the duty of the agriculturist, whose lot perhaps is too much envied.

For my part, I have had in my agricultural career some hard experiences.

In January, 1871, when I returned to Burtin, after having taken part in the defence of Paris, I found my stables entirely empty; the typhus had carried off in a few days 63 horned animals out of 64. By successive increase with Norman bulls, which I had changed every two years, I had created for myself a new and very fine race, and my stables were justly renowned in Sologne. In ten days I had lost the fruit of twenty years' labor. The blow was severe, but I hardly felt it. What was the loss of a few thousand francs compared with the great national grief which was causing all our hearts to bleed? I began again my work with courage. I bought young animals to replenish my stables, which continually improve, but I am aware that time will fail me to replace what I have lost. Let us strive courageously. Perhaps the most obscure of the pioneers of agriculture brings you to-day an effective means with which you can charm away the dearth of fodder, which is one of the greatest plagues of agricultural industry.

Do not deny to this poor but interesting Sologne the honor of having been the cradle of a system of ensilage that is effectively preservative, and of having given an example that the richest countries will not be slow to imitate. This is my earnest prayer and brightest hope.

Monsieur Goffart was awarded by the French Government in 1876 for this invention, the Decoration of the Legion of Honor.

APPENDIX.

REPORT TO THE CENTRAL AGRICULTURAL SOCIETY OF FRANCE BY A COMMITTEE OF THE SECTIONS ON LIVE STOCK, PHYSICO-CHEMICAL AND HIGH CULTIVATION, UPON THE SUBJECT OF THE ENSILAGE OF GREEN CUT CORN FODDER.—SEANCE APRIL 7, 1875.

YOUR committee considered that the question of the preservation of a fodder so productive and so desirable as maize deserved to be studied, and if the results should be found as satisfactory as M. Goffart has announced, it should be brought to the attention of the agricultural public; therefore, I have been directed to present to you our report upon this important subject.

All methods of preservation of food interest deeply the farming community which produces it, and the whole nation that consumes it. It tends to reduce losses by deterioration and by waste; it mitigates the deplorable alternations of low prices for crops, which ruin the agriculturists, and of high prices, which weaken every portion of the commonwealth. Finally, it insures regular food to animals and men, which increases the energy and adds to the productive power of the nation. The preservation of maize in a green state lends a special interest to the value of that fodder for milch cows, because the crop is so variable, according to the season, and the time for consuming it in the autumn is so short if not preserved. When the heat and moisture of the season favor the vegetation, it produces such large crops that it cannot be con-

sumed before the frost destroys it, while the dried leaves and stalks are of very little value. Many agriculturists who have introduced this excellent fodder in their business have tried various ways of preserving for the winter what could not be consumed in the autumn, with results more or less satisfactory, but oftener the latter. There have been many precedents of a nature to justify these efforts. The preservation of grape leaves green near Lyons for the food of cattle and goats has made a high reputation for the cheese called Mont Dore from time immemorial. Apple pomace has been preserved in silos with good results. In various parts of Germany the preservation of vegetables of all sorts—turnips, cabbages, and different kinds of leaves seasoned with celery for feeding cows—runs back as far in the night of time as that of sour cabbage (*sauer-kraut*) for the food of men. In the north of France, several large agriculturists have preserved for twenty years in silos the leaves of beets, also the beets cut across, which have kept better than the whole beets in cellars. The pulp of beets, from distilleries or sugar factories, also makes excellent fodder when kept in silos. The world is so old, necessity has so long compelled the efforts of human beings, that we may find precedents in every line of improvement. But all experienced men who know the great difference that separates a happy suggestion, or even a successful attempt, from a practice well enough confirmed to become the base of a regular business, will admit that these precedents do not destroy the merit of any man who, like Monsieur A. Goffart, has accomplished a continued success. If the cultivation of maize and the method of ensilage have given the results that he claims, and the samples submitted indicates, he merits our eulogies.

M. Goffart states that he commenced to experiment with maize and ensilage in 1852, and what we have seen at Burtin proves that his experiments have led him to a practical success. We have been very favorably impressed by the silos that were

located in the old distillery which had been used for the daily feeding of the cows. These silos were made by lateral walls of two and a half metres in height, without any excavation, and the maize piled upon the ground as high as the floor above permitted. M. Goffart had thought best to cut the maize fine before ensilaging it, for the following reasons: First, a more uniform mixture of short straw with leaves and stalks; second, a division of the stalks in short pieces makes them more easy for the animals to masticate, and with less waste; third, a packing down more regular and more effective in the mass.

NOTE.—The further description of the process of ensilage is omitted, as the preceding directions are the result of later experience, by which the author learned to avoid *all* fermentation.

The fodder has an alcoholic odor, quite marked and slightly acid. It is eaten with avidity by the cows, and constitutes their sole food since the commencement of winter. We were struck by the healthy appearance of the 28 or 30 cows—their eyes were bright, the skin soft, and they were in good condition. But the point that above all attracted our attention was the sucking calves, which are the most delicate, and are always the first to suffer from any deficient or bad food given to their mothers. We did not see a single one that had hair in bad condition, or that was scouring. The fodder that produced this excellent result contained neither salt nor oilcake, and one would naturally inquire if it would be sufficient in all cases. It is probable that for very good milkers, where the quantity per day is 25 to 30 litres, it would be necessary to add some meal or oilcake to the ration of maize which we saw distributed, and which weighed 28 kilogrammes per day; but for the cows in the stable of M. Goffart, weighing alive 400 to 500 kilogrammes, this ration seemed to be sufficient for them and their calves. In order to show the importance of the preservation of maize, I will give only one figure, which is, that a crop of 120,000 kilogrammes per hectare corresponds to about one-fifth its weight of dry

NOTE.—A litre is about $1\frac{3}{4}$ pint.

substance per hectare—a magnificent result, superior by far to that which can be obtained even with beets raised for food of cattle in the lands similar to those of the domain of Burtin. The stock produces a great mass of manure. These facts have had a very happy influence upon the business at Burtin, and which perhaps will serve as an example to a country which, notwithstanding the immense amelioration which it has derived from railroads, by bringing to it marl and phosphate fertilizers, has need to pass beyond the uncertainty in which it has for a long time languished. We have not thought best to enter into a discussion as to net profits, always quite delicate, because the price varies so much, according to the commercial circumstances of the locality, and the local management of each business. It is evident that a cultivation of maize which produces 60,000 to 100,000 kilogrammes of stalks per hectare, which must be carried to the machine, cut, carried, and packed into silos, and afterward taken out, involves a considerable expense. But it is evident also that a plant which produces such quantities of excellent fodder is the base of a profitable cultivation. It is not less evident that, if the business is laid out in a judicious manner, so as to avoid all unnecessary manœuvres and portage, as is observed by factories, the cost can be reduced to an almost incredibly small figure.

It is not well to advise farmers, whose means are often already insufficient, to invest an important part of their capital in constructions; but we should call their attention to the consequences of the continual elevation of the price of hand labor, and the scarcity and increasing worthlessness of farm hands. We cannot operate to-day as we formerly did, because the successive operations of opening and covering the silos in a distant field, the time lost in going and coming without overseeing, and the force wasted in transportation in bad weather, have become too costly. We see no reason why a silo under shelter may not be constructed with such economy

that the ensilage of 1,000 kilogrammes of fodder may net as low a cost as in silos made in the ground.

We hope also to report soon to the Society some figures which concern another sort of granary, and which prove that 1,000 kilogrammes of oats may be kept in chests of iron, which protect it from all risks at less cost than in the usual grain bin.

Finally, our conclusion can only be very favorable to the efforts of M. Goffart. We find that he has made a remarkable success, in having created a business based upon the cultivation and preservation in silos of maize fodder. He has created in the midst of poor Sologne a type of agriculture which should be cited as an example, even to those parts of the country that are better conditioned. He merits, therefore, the thanks and congratulations of the Central Agricultural Society of France.

These resolutions were put to vote, and unanimously carried.

THE ANALYSIS AND COMPOSITION OF MAIZE CUT IN GREEN STATE.

FROM a letter to M. A. Goffart, from J. A. Barral, Perpetual Secretary of the Central Agricultural Society of France, editor of *Journal de l'Agriculture* :

You do not seek to produce a fermentation in the cut fodder. You propose to maintain all its parts in a condition as near as possible like that of the plant at the moment that it is cut. I have undertaken the solution of a question of vegetable physiology which presents a scientific interest, and also a practical interest of the first order.

It is important to ascertain what is the distribution of mineral and organic matter in the different parts of the stalk of maize. When it is cut for the silo it becomes a mixture of all

parts of the plant in such a manner as to give to the stock those that are richest in nourishment as well as those that are poorest. This is one of the advantages of the method which you have used so many years. If you give the corn plant to the stock in the natural state, they will eat first the tender parts, and will leave the hard parts, which offer the most resistance to the teeth and which have the least flavor.

I have taken thirteen stalks of maize, weighing altogether 16.⁷⁹⁵ kilogrammes, and have cut them up into six lots, as follows: Each of these lots has been desiccated at 100 degrees (R.). The stalks were cut into three parts. The length of each portion was, Upper part, 0.65m.; middle part, 0.88m.; lower part, 0.80m.; the average total length of each stalk, without tassels, being 2.33m.

	Weight in green state. Grammes.	Weight after de- siccation. Grammes.	Water, or Loss, per cent.
Leaves	4.805	1.315	72.63
Tassel .....	.102	.047	56.07
Ear, with stem	3.026	.752	75.14
Upper part of stalk	1.270	.125	90.15
Middle part of stalk	2.446	.341	86.06
Lower part of stalk	5.146	.661	87.15
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The thirteen stalks	16.795	3.241	80.76

Thus, the water was quite unequally distributed in the stalk. They were more watery at the upper part, but the flowering portion was much less; the grain was still milky. The relations between the different parts of the plant are found to be as follows:

	Normal state.	Dry state.	
Leaves	29.20	40.57	
Tassel .....	.66	1.42
Ear, with stem	18.01	23.20	
Upper part stalk	7.56	3.85	
Middle part stalk	14.86	10.52	
Lower part stalk	30.01	20.44	
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	100.00	100.00	

This shows that the stalks, when fresh, surpass in weight the remainder of the organs of the plant. They contain, however, a less proportion of dry matter, and less than the leaves, which have in the fresh state a much less weight. I have analyzed separately each of the six lots, and I have obtained the following composition in organic substance and ashes, or mineral substance :

	Leaves.	Tassel.	Ears.	Stalk			Entire Plant.
				Upper.	Middle.	Lower.	
Organic substance.	89.01	94.80	98.30	95.43	97.31	98.26	94.26
Ashes or mineral substance	10.99	5.20	1.70	4.57	2.69	1.74	5.74
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Thus it is seen that the mineral substance is accumulated in the leaves and upper part of stalk.

Here are the exact proportions of the mineral substance in the different organs of maize :

Leaves	77.70	Middle part of stalk.....	4.87
Tassel	1.22	Lower part of stalk.....	6.29
Ear and stem.....	6.79		
Upper part of stalk.....	3.13		100.00

Thus, more than 77 per cent of mineral substance is accumulated in the leaves, more than 14 per cent in the stalk, and only about 6 per cent in the ear.

We will now ascertain the composition of the different parts of the plant, as appears when desiccated :

	Leaves.	Tassels.	Ears.	Stalk.			Entire Plant.
				Upper.	Middle.	Lower.	
Nitrogenous substances.	6.28	6.27	11.09	4.34	3.86	3.37	6.47
Fatty matter soluble in ether	1.30	1.90	2.50	1.00	.40	.30	1.28
Saccharine matter soluble in alcohol.....	6.50	4.70	8.30	17.50	20.60	21.00	11.77
Starch	64.33	25.23	73.51	39.49	38.65	35.79	56.35
Cellulose.....	10.60	56.70	2.90	33.10	33.80	38.00	18.37
Mineral substance.....	10.99	5.20	1.70	4.57	2.69	1.74	5.74
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total.....	1.004	1.004	1.775	.694	.617	.540	1.033

The ear is found, as we would expect, much richer in nitrogenous substance than the other parts of the plant. The nutritive power, as it is agreed to define it, by the relation of azotic substance to the sum of the fatty matter, sugar, and starch, is quite inferior in the stalks to that of the other organs, as the following table shows:

	Taking the ear as unity, the proportionate nutritive power is as follows:	Nutritive value of whole plant.
Leaves.....	.66	2.54
Tassel	1.49 .....	.09
Ears.....	1.00	2.57
Upper part stalk.....	.57 .....	.17
Middle part stalk.....	.49 .....	.41
Lower part stalk.....	.45 .....	.69
		—
		6.47

The stalk, however, shows that it is very rich, and, above all, the leaves, which therefore should be taken care of for the cattle. The fatty matter is concentrated in the leaves and in the ear; the saccharine matter in the leaves and stalk, and mostly in the lower part of the stalk.

The following table indicates the concentration of saccharine matter in the leaves and stalk:

	Each part contributes	The different parts to whole.
Leaves.....	2.64	22.36
Tassel .....	.07 .....	.59
Ears.....	1.93	16.41
Upper part stalk.....	.67	5.69
Middle part stalk.....	2.17	18.45
Lower part stalk.....	4.29	36.50
	—	—
	11.77	100.00

Cellulose substance is, as we would expect, in large proportion in the stalk, and mostly toward the lower part of it. It is principally in the leaves and ear, with stem, that the

starch and the other principles which are neither cellulose nor nitrogenous nor mineral, are found.

CENTESIMAL COMPOSITION OF THE ASHES OF EACH PART OF THE PLANT, AND DISTRIBUTION OF THE SAME.

	Entire Plant.	Leaves.	Tassels.	Ears.	Upper Part Stalk.	Middle.	Lower.
Phosphoric Acid	7.17	3.97	10.01	33.50	9.07	14.02	7.17
Sulphuric Acid	3.81	3.21	6.13	3.58	5.61	8.65	3.81
Chlorine	1.35	1.04	2.73	3.52	2.15	trace.	1.35
Potash	4.41	1.23	7.88	27.11	14.61	2.41	4.41
Soda	8.26	6.78	10.37	21.36	12.57	8.39	8.26
Lime	12.96	13.78	11.87	3.46	10.29	14.31	12.96
Magnesia		6.60	5.64	15.03	7.04	10.52	8.73
Iron		0.51	0.46	0.11	trace.	2.08	0.63
Silex	54.75	63.76	35.83	0.34	29.83	41.37	54.75
Carbonic Acid and Waste	0.18	0.13	0.03	0.09	3.27	1.49	0.18
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The above table shows that the ears are the richest in phosphoric acid and potash. These also contain the largest percentage of soda, the least of lime and silex. As to the distribution of each mineral element in the different parts of the plant, it is necessary, in order to study it thoroughly, to enter into a more detailed and separate examination. Phosphoric acid or phosphorus plays an important part in agriculture, not because it is more indispensable to vegetation than several other elements, but because nature has not distributed it with so much profusion in all lands or in the atmosphere as certain other elements that on that account are considered secondary. Indeed, there is not any one element in vegetation of any greater importance than another, and if any person judges otherwise it is because he places himself at the point of view of an agriculturist who, having need to produce certain crops of a special kind, needs to accumulate such elements as enter specially into their organization. Therefore, in order to obtain abundant food, in order to produce with rapidity domestic animals, whose organs require much phosphorus, it is

necessary to seek methods for increasing the supply of phosphates, more or less assimilable, that the plants may find in the bed where their roots develop. To indicate the sources of the supply, whether in the residuum of factories or of the household, or in the numerous repositories, has been one of the greatest services rendered in modern times to agriculture by chemistry and geology. But there our knowledge ends. We are entirely ignorant as to how the phosphorus distributes itself in the vegetable, by what processes it penetrates and circulates, and accumulates in certain organs, or exactly what these organs are.

As to the relative distribution of these elements, the following tables show, as far as concerns maize fodder intended for green preservation by ensilage:

PHOSPHORIC ACID.

	Amount in each part.	Proportion in different parts.
	Grammes,	
Leaves,	0.177	42.96
Tassel	" 0.007	1.70
Ears	" 0.132	32.04
Upper part stalk	" 0.020	485
Middle part stalk	" 0.026	631
Lower part stalk	" 0.050	12.14
Whole plant, dry	" 0.412	100.00

SULPHURIC ACID.

The role of sulphur in vegetation is nearly unknown. All that we know is that it is absolutely necessary. It is generally found in less proportion than phosphorus; in maize as 88 to 180.

	Quantity in each part.	Proportion in different parts.
	Grammes,	
Leaves	0.144	65.75
Tassel	" 0.005	2.28
Ears	" 0.014	6.39
Upper part stalk	" 0.009	4.11
Middle part stalk	" 0.016	7.30
Lower part stalk	" 0.031	14.17
Whole plant, dry	" 0.219	100.00

CHLORINE.

By the conclusive experiments of Prince de Salon-Horstmar, we know that chlorine is indispensable to the regular operations of the different phases of vegetation, but the most complete obscurity rests upon its real action.

	Quantity in each part.	Proportion in different parts.
	Grammes, 0.047	60.26
Leaves	" 0.002	2.56
Tassel	" 0.014	17.95
Ears	" 0.009	11.54
Upper part stalk.....	" 0.006	7.69
Middle "	" traces	traces
Lower "	"	
Whole plant dry.....	" 0.078	100.00

POTASH.

Berthier's saying, "No plant without potash," has become a maxim.

	Quantity in each part.	Proportion in different parts.
	Grammes, 0.055	21.94
Leaves	" 0.006	2.27
Tassel	" 0.107	42.29
Ears	" 0.036	14.23
Upper part stalk.....	" 0.041	16.20
Middle "	" 0.008	3.17
Lower "	"	
Whole plant dry.....	" 0.253	100.00

SODA IN MAIZE.

In the whole plant dry, 0.475 grammes, of which two-thirds is accumulated in the leaves, and one-sixth in the ears.

LIME IN MAIZE.

Lime has been considered necessary to plant growth from a very ancient period. More than four-fifths are found in the leaves, only two per cent in the ear, and the quantity increases in descending the stalk.

MAGNESIA IN MAIZE.

The role of magnesia in vegetation has been but little studied. There is no doubt, however, after experiments made in Germany, that its presence is indispensable to plants. Two-thirds of it is found in the leaves, and the remainder equally divided in the other five parts of the plant.

IRON IN MAIZE.

Iron is evidently of great importance to the life of animals who are nourished by vegetation; as with sulphur, chlorine, soda, lime, and magnesia, the greatest accumulation is in the leaves. But it is a noticeable fact that it is absent from the ear, which would seem to explain the opinion of physicians as to the insufficiency of corn-meal for exclusive human food. As to maize harvested green in order to be fed to cattle after ensilage, the lack of it in the ear is equalized by its presence in the other parts of the plant.

SILICA.

It is probable that all silica enters the organs of vegetation in the soluble state. The quantity found is very considerable.

	Quantity in each part.	Proportion in different parts.
	Grammes,	
Leaves	2.843	90.45
Tassel	" 0.026	0.82
Ears	" 0.001	0.03
Upper part stalk	" 0.042	1.33
Middle "	" 0.084	2.67
Lower "	" 0.147	4.70
<hr/>		
Whole plant dry	" 3.143	100.00

Thus the stalk contains only about one-tenth part of the amount contained in the leaves, which contain 90 per cent of the whole plant.

INTRODUCTION OF ENSILAGE IN THE UNITED STATES.

BY MR. FRANCIS MORRIS,
OF OAKLAND MANOR, HOWARD COUNTY, MARYLAND.

I HAVE been requested to give my experience in growing corn fodder, preserving it in silos, or trenches, and feeding it to stock.

In the early summer of 1876, I received from France a newspaper containing an account of the plan they had adopted of raising maize, or Indian corn, cutting the same when in tassel, and burying it in trenches, covering it with earth, and feeding it out to their stock in the following winter or spring. This statement induced me to make the experiment. I sowed, on the 1st of August, 1876, about five acres, in drills three feet apart, and about a bushel of corn to the acre. This was worked twice with a cultivator, and was in tassel in the first days of October. We cut the same with a mowing-machine, carried it in wagons to the feed-cutter, cut it up in one-inch pieces, and added to it an amount of wheat straw, cut up in the same manner, equal to one-fifth of the corn fodder. I had three silos bricked up inside a stone barn. The silos were about ten feet deep and four feet wide, and twenty-four feet long. The fodder was well packed down by trampling while the mixture was put away, and then covered with boards with large and heavy stones upon them. After the weights had pressed it down very considerably, they were taken off, the boards covered with straw, and then with clay; the latter were thoroughly packed, and the whole was made a perfect protection against the oxygen of the atmosphere penetrating through the clay or earth. The first silo was opened for use on Christmas, and I fed all my milking cows with the same. Two of them refused to eat their portion, and when they left their stalls the other cows ate it; and from that day I have

never fed it to an animal that has refused it—horses, mules, oxen, cows, sheep, and pigs will all leave any other feed and eat this by choice.

In the year 1877, from want of personal attention and from a very dry time, my corn fodder was not as large a crop as it should have been, but it was sufficient to feed nearly a thousand head of stock for over two months; it was equally good in quality as it was in 1876.

For this year I have more than double the quantity of this fodder. I have made and filled a very large silo out of doors, which will probably hold from fifty to seventy-five tons, besides filling the three silos in my barn. I have a very large herd of stock dependent on my corn fodder for their winter feed, and I feel every confidence that it will furnish me all the feed I require.

In a very long experience in raising stock, I have found corn fodder preserved as above stated the best food for milking cows that I ever used. It is equal if not superior to June grass, and its cultivation is so easy, its preservation so inexpensive, that to-day no one can estimate its advantage to the agriculturist. The average hay crop of this State (New York) is not equal to one ton per acre, and every farmer knows what a costly crop it is to raise, to cure, and to preserve after it is raised, while our Indian corn crop will grow and flourish and tassel with the most ordinary care and tillage. Twenty-five tons to the acre, with a light dressing of barnyard manure, and working it twice with a cultivator, is a small crop. Add to the barnyard manure a dressing of guano, and more than double that quantity can be raised to the acre—I am almost afraid to state the quantity that can be raised per acre. Suppose, however, we put the produce down to twenty-five tons per acre—and every one who has raised corn sowed broadcast will recognize that this is a small crop—what will be the result in this good State of New York if one-tenth of her arable land is used in this way? Where is the stock to feed

upon the new supply of food? It is not here. We should have to double the number of our horses, cows, sheep, and all our stock, and after we have done that we should have to double them again. In fact, the amount of stock that could be maintained is so great that we should be wholly independent of the West, for the most liberal supply of beef and mutton will be supplied by the cultivation of our own lands. The beef that we shall have when we make a proper use of preserved green food will be very different from the beef fattened on slops procured from the whiskey stills of Chicago and other cities of the West. The old adage, "No cattle no corn," is fully verified by our wheat production in this State. The lands are all so indifferent in quality that he must be a bold farmer who now sows a field of wheat; but the corn-fodder, which it is now proposed to raise, will give such a yearly amount of manure as will enable every farmer to get a wheat crop of thirty to forty bushels of wheat to the acre, and succeed that by good clover. After that is done, his progress to a maximum yield of cereals will be very rapid, and I have every confidence that the crops of this country, blessed with its tropical sun, will exceed in value and importance that of any other agricultural country that can be named.

FRANCIS MORRIS.

December, 1878.

NOTE.—Mr. Morris has increased his silos to a capacity of 1,000 tons.

RECENT IMPROVEMENTS IN PLOWS.

THE improved American plow holds a high rank among the implements of modern husbandry, not only at home, but in the foreign market. In form, materials and construction, it appears to be all that it is capable of being, and yet there are constant developments of new points of excellence. The most obvious improvements within the last few years consist in the use of hard metal, first for the edge, and later for the entire wearing surface. Chilling the edges and point of the share and the bottom of the land-side, was the first step in the line of progress, made about thirty years ago, but within the last ten years attention has been directed to the importance of reducing the friction of the mold-board. Hardened steel was introduced for this purpose, and is still recognized as the best material where soil is wholly free from grit, but it was found that a chilled surface of cast iron, in combination with the chilled share and land-side, was more easily and economically kept in repair in all soils containing grit. The well-known process of chilling first resorted to, consisted in running the molten metal against the surface of cold iron. This method, while rendering the metal harder, made it correspondingly brittle, and required great care in the mixture of the iron to make the chill penetrate uniformly. This plan also required a method of annealing, sometimes with hot water, or by building fires on the back of the mold-board, and sometimes by covering with heated sand.

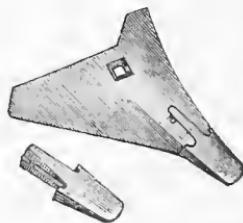
Later improvements in mixing metal have been successfully made, so as to secure entire hardness throughout, without the chilling process. Plows made in this way are usually known by appropriate names, such as "Adamant," &c. We learn through a large plow-making establishment in New

York (the New York Plow Company), that long experience has taught them that steel in a certain condition will mix with melted pig iron, and with the addition of certain chemicals will make a homogeneous metal by pouring it into molds at the right time, which time is ascertained by means of its color. In this way the result is "hardness, uniformity and strength."

In former years, plows made of cast iron were so rough that farmers were severely tried in keeping them bright. As plows have grown harder, the polish is more difficult to produce, as well as more durable, and on the metal here referred to, is said to suffer little from corrosion. As the friction of the plow is equal to about thirty-five per cent of the whole force of the draught, every expedient to reduce it is important to the plowman.

A still better improvement in this direction was recently achieved by the introduction of a reversible point in the share, which thus becomes self-sharpening, and enables the farmer to keep the bottom of the plow level, thereby avoiding the friction that arises from a projection of the point of the share below the general level. It has been found that the effect of a sharp point is to sharpen the wing also. Among other improvements is the setting of the beam in the centre instead of one side of the line of resistance, which is adjustable at the standard so as to produce a balance, avoiding side draughts.—*From Iron Age.*

N B.—All these improvements are contained in the **Adamant Plows** of the **NEW YORK PLOW COMPANY**.



ADDENDA

To ACCOMPANY "ENSILAGE OF MAIZE," BY J. B. BROWN,
 55 BEEKMAN STREET, NEW YORK.

EXTRACT FROM JOURNAL DE L'AGRICULTURE,
 OCTOBER 19, 1878.

M. A. GOFFART, desirous of making known the remarkable results that he has obtained from the cultivation and preservation of maize-forage, invited to his celebrated farm at Burtin, on Oct. 12, many agriculturists who are interested in this important question. A hundred accepted his invitation, and they received at Burtin the most generous hospitality. Among those present we should mention the Prince Catacuzene, a large agriculturist of Southern Russia and Russiau Commissioner to the Exposition; M. Fernandez de Neda, Commissioner from Spain; M. Rob Runeberg, Commissioner from Finland; M. Deutch, large agriculturist in Hungary; M. Boitel, Inspector-General of Agriculture of France; M. J. A. Barral, Secretary of National Society of Agriculture of France; and the officers of eight other agricultural societies of France. There were also a director of a school-farm, a director of a penal colony, proprietors or estates in different parts of France, mayors of cities, manufacturers of agricultural machinery; also Mousieur de Fontenailles, a distinguished silvi-cultivator (forest tree cultivator, a branch of industry now attracting much attention in Europe, as a remedy for drought). We left Paris in the morning by special train to Nouan-le-Fuzelier. A few minutes' ride by carriage and we are at Burtin, where a magnificent banquet, prepared under an elegant tent, awaits the guests. The first toast is to M. Goffart, the last to Sologne, "too little known, and which the skillful pioneers of the thirty years last past have so happily transformed." After the banquet came the more important business. The operation of gathering and ensilaging the maize had been under way for several days. One of the silos was already full, the second was being filled. The gigantic maize is brought from the field in wagons, which stop just behind the feed-cutter. The stalks are fed to the machine, which is run by a steam-engine. They are cut into disks of one centimetre long (about 4-10 inch), and carried by an elevator above the wall of the silo, and fall within it. A man spreads the layer, a woman tramples around the silo. When it is full it will be covered with plank, which will be loaded with large stones about 400 kilogrammes (about 900 lbs.) per square metre (about 10 $\frac{1}{2}$ square feet). It will be perfectly preserved, without fermentation, until the time when it is needed for use. In the month of May we took from the last silo at Burtin the last layer of maize. It had the same temperature that it had at the time of ensilage, and it presented not a trace of any deterioration. There is no doubt that the result will be the same this year. All the agriculturists

who have followed exactly the directions of M. Goffart have obtained the same result, and their numerous testimonials bear witness to it. (For full description of M. Goffart's process, see *Ensilage of Maize, &c.*) There are three silos for maize, and one for oats, cut green, which was filled in the Spring, and which has been fed out to the working animals.

M. Goffart has to-day 68 horned cattle in his stables, six horses, and one mule. With his resources of maize fodder, he can not only support for seven months 150 horned cattle, but also put them in condition for the butcher, upon 32 hectares (about 79 acres). After having visited the fields of maize, the numerous guests departed, delighted with what they had seen.

THE CULTIVATION AND PRESERVATION OF MAIZE-FODDER.

LETTER FROM MONSIEUR A. GOFFART, APRIL 28, 1878.

MY last silo, more than 300 cubic metres in capacity, will be emptied by May 10th. You will remember how my frosted maize last September had to be cut as quickly as possible, when it had only attained two-thirds of its growth. The frost had completely stopped its growth, and the blackened stalks would have fallen to the ground at the first rain. I cut it, as I always do, one centimetre (about 4-10 inch) long, and I ensilaged it without any addition of salt or straw or cut hay. The preservation has been, and is still, *perfect*; not a kilogramme of it has been wasted. Having been cut when so very young, it has produced a very tender fodder, the nutritive power of which was evidently superior to that of my previous ensilage. The question arises, whether this increase of nutritive value compensates for the loss of weight in a crop cut prematurely. I do not think it does. It would need to be 30 per cent. at least superior to that of maize cut when the ear is in the milky state, for the loss of weight is at least in that proportion.

Comparative experiments and analyses of our skillful chemists will soon enlighten us on this important subject.

Another very remarkable effect upon ensilage by frosted vegetation is this: while maize ensilaged in ordinary condition takes on the alcoholic fermentation in twelve to fifteen hours after contact with the air, the frosted maize required two, and sometimes three days. The farmer, therefore, need not be alarmed at these premature frosts, but should be ready to ensilage his crop immediately upon their appearance. I find that the tall Mexican corn becomes exceedingly hard, and quickly dulls the knives of the cutting machine. I shall not use that kind again.

Feb. 1, 1879.—I now give you the facts which I have gained from the experience of the past year, at my farm at Burtin. I find that I was mistaken when I advised that the silo should be filled as quickly as possible. The shrinkage or subsidence which takes place in the first few days of the compression, is so considerable that the upper half of our silos are soon empty, and therefore we lose one-half of the capacity, and the expense of establishing them is just doubled. I now advise that the silos should not be filled too quickly. In recharging a silo that has been commenced with a layer

of fresh maize of fifty centimetres (20 inches) each day, you will keep sufficiently ahead of the fermentation during the ensilage, and the spontaneous shrinkage will have been sufficient at the end of eight or ten days, of daily refilling, so that the subsequent subsidence will not exceed one-tenth of the total height. My silos, filled this Autumn, are more than five metres high, and only show a void at the top of half a metre. By having two or several silos of a certain capacity, the work can go on continuously. Some farmers have ensilaged this year 100,000 to 120,000 kilogrammes per day (220,000 to 264,000 lbs.).

My maize is cut in the field by women, with sickles. They have great skill in the use of that implement, and eight women will cut easily one hectare a day ($2\frac{1}{4}$ acres). They receive 15 francs per hectare, and therefore earn about two francs a day each. I found a difficulty in roofing over my three united silos, on account of the great size of the group thus formed. On this account I would prefer to unite only two silos, and increase the length, while preserving the other dimensions, so as to obtain the same capacity. Something would be gained also by replacing the semicircular ends with arcs of a circle of a greater radius, which would diminish the expense of roofing, and increase the capacity, without, I think, endangering the preservation of the maize.

The proximity of the silos to the stables is important, as to economy of labor, but it is an advantage sometimes to put them at a distance, as the land may be more suitable. The solidity and the smooth working of the cutting-machine are of great importance. The French machine, with eight horse-power, will cut 100,000 to 120,000 kilogrammes per day, in pieces of one centimetre long (4-10 inch), and costs 800 francs. If water invades a silo, whether it enters from without or from compression upon maize that is very wet at time of ensilage, it should not be wasted; cattle will drink that kind of grass-soup with great avidity.

When I opened, last October, the silo in which I had enclosed in May about 60,000 kilogrammes of green rye, I found it darker in color than usual, and it exhaled a disagreeable odor, indicating the presence of butyric acid. Although this odor is disagreeable to man, it does not cause to animals the same repugnance, and my rye was eaten entirely, and without the least hesitation. Never before had my ensilaged rye presented this kind of alteration. The alcoholic fermentation, though less than in maize, had always before developed sufficiently to make it agreeable, both in taste and smell, to both man and beast.

There was, therefore, an abnormal effect, a special alteration, which it is important to avoid, since, when it passes certain limits, it will disgust the animals and also injure their health, if we persist in feeding it to them. At the time this rye was cut down for ensilage it had been *fallen* for a long time, and the foot for more than eight inches had yellowed; it was already undergoing the commencement of decomposition. To prevent this I used salt in considerable quantity, but it had not served to neutralize the effect of the evil; the butyric fermentation had already invaded the ensilaged vegetation, and this fermentation remained, notwithstanding the presence of the salt. I believe, however, that in this case salt was useful, suspending by its antiseptic qualities the decomposition, and assisting to excite the appetite of the animals, who, perhaps, without the salt, would have refused it, since the more important condiment, alcohol, was absent.

I ensilaged in September several wagon loads of clover that was fully ripe and had fallen for several weeks, and though I took special care with it, and compressed it very energetically, and mixed salt with it, viz., 3 kilogrammes to the thousand, on discharging the silo at the end of December, I found a blackened mass, viscous, and nearly insipid.

This ensilage was entirely eaten by the animals without any aversion, but it quickly contracted butyric acid, and if it had been exposed to the air for a considerable time the animals would have manifested an increasing aversion, and finished by refusing to eat it. I have frequently observed this in ensilaging whole maize. I give this explanation with hesitation, because so much obscurity still rests upon the science of fermentations. When the butyric fermentation permeates an ensilaged mass, and this mass is exposed to the air, does there not form, to the detriment of the nitrogen contained in that mass, a liberation of butyrate of ammonia, which impoverishes the alimentary matter and finishes by taking away all its nutritive power? The animals thereupon refuse to take into their stomachs a food which is fictitious, its nourishment being exhausted.

Vegetation which has been attacked by butyric acid, before cutting, in the field, needs also to be covered and compressed *at once*, or the air that is not expelled will increase the activity of the pre-existing acid. Prickly comfrey, notwithstanding great pains taken, I have found refractory to alcoholic fermentation, and when exposed to the air quickly becomes invaded by butyric acid, requiring quick consumption in order to save it. While this plant is a very excellent fodder, it is well known to be poor in saccharine matter. Therefore, alcoholic fermentation may fail in two cases: when sugar is not abundant in the ensilaged material; when a considerable alteration existing at the time of ensilage prevents its development.

EXTRACT FROM A LETTER OF M. DE BEAUQUESNE,

ONE OF THE MOST DISTINGUISHED AGRICULTURISTS OF FRANCE.

December 17, 1878.

"I am preparing a series of articles on ensilage. I send you the part relative to the cost. I have a feed-cutter, with three knives, cost 800 francs (\$160). I tie the stalks in bundles of about 10 kilogrammes, using for that one of the stalks. Two men take the maize from the unloaders and place it on a narrow table prolonging the box of the cutter; another man passes it along to the man that feeds it to the machine. I have two men in the silo. Thus I make the cost:

Five laborers at 35 cents	\$1 75
One mechanic at cutter	50
One engineer.....	70
Coal, 330 lbs.....	1 50
Oil.....	15
Use of engine.....	2 00
Use of feed-cutter.....	1 00
Incidentals.....	40
	<hr/>
	\$8 00

"Ten bundles pass easily per minute, making 925 lbs. or 13,500 lbs. per hour; but as there is time lost in oiling and examining knives and removing them to sharpen, I only reckon 9,000 lbs. per hour as regular result. This gives a net cost of 20 cents per 2,250 lbs. *Ce n'est rien.* I have not tried with a horse-power, but I have it from a neighbor that it costs 60 cents for 2,250 lbs. This is still endurable. I am about to make an experiment to determine the comparative nutritive value of hay and ensilage. One of my milch cows has fed a month on the latter. I believe that its nutritive value is more than one-third, and I shall not be surprised if 220 lbs. of maize are worth at least 110 lbs. of hay, and probably more."

"I have just let a farm ou shares, and the party stipulated that I should let to him my steam-engine and feed-cutter, because there was a silo, and it was only for that reason that he took the place. I say frankly that I believe we have made a mistake in our successive plantings of maize, in order to feed it green. It would do better to harvest it all at the same time, and ensilage it all. There would be more economy, and the maize that we should use, after being three weeks in the silo, would be more nourishing. I shall do it so next season. The later planting often gives bad results, and the ground is not so easily worked."

Monsieur Goffart remarks upon this letter: "My ensilages the past year reached more than 132,000 lbs. per day, and the cost per ton was 25 per cent. less than his figures, which can be explained by the fact that my machinery was more powerful than his."

"I agree with M. de Beauquesne as to the relative value of ensilaged maize and hay. Ensilaged maize at Burtin is worth in nutritive power one-half that of hay; but our hay in Sologne is poor, and in other countries the relative value of maize may decline to one-third."

"M. de Beauquesne, after giving in detail the different expenses of ensilage, adds, 'it is nothing.' I will go farther than he, and I will say, this expense constitutes a considerable saving. The expense of cutting and ensilaging a million of kilogrammes of maize is, at most, a thousand francs. Instead of proceeding, from day to day, to cut up the maize for the day's sustenance of your animals, you prepare in 15 days the food for 200 days; you have put your maize in such a condition that the stable-man has no other trouble but to fill his basket in the silo and empty it in the manger. Here are some figures in proof of this statement."

"On a farm in the valley of the Loire are fattened each winter a certain number of animals, with beets, hay, and oil meal. Twelve animals on this diet require the steady work of a strong laborer, who washes and cuts the beets and chops the hay or straw. This laborer is paid 45 cents per day. He receives, therefore, $3\frac{3}{4}$ cents per head. At Burtin, with the ensilage at three steps from the stable, two men, at the same wages, take care of 80 animals, making a daily expense of 1 $\frac{1}{2}$ cents per head. The difference in favor of Burtin is more than 10 francs per day, and this saving is more than double the sum expended for ensilage."

"The last paragraph of the letter, relative to the advantage of feeding only ensilaged maize, even in summer, agrees perfectly with my ideas. I wrote in 1875, in one of my pamphlets, 'It should never be lost sight of that to cut, and to ensilage in a way to obtain a good fermentation, is to increase enormously the alimentary value of maize; and I ask if, even in autumn, when the fresh maize is abundant, it would not be an advantage to pass it through the silo.'

"In order to settle this question careful and intelligent experiments are necessary, and no one is better able to resolve it with authority than M. de Beauquesne."

THE SYSTEM OF ENSILAGE.

BY J. B. BROWN.

ANY improvement in the methods by which the nutritive power of vegetation can be prolonged is of greater importance to the farmer who produces it, and to the nation that consumes it than any increase of production. Population in time adjusts itself to the average production of the land, but *preservation* of crops mitigates the alternation of low prices and high prices, and insures regular food to animals and men, thereby increasing the energy and happiness of the commonwealth. The country that does not possess methods and ample facilities for storing food is subject to famines, without regard to the average prolificness of the soil. In England, in the 12th, 13th and 14th centuries, there occurred a famine once in fourteen years. A crop which can be produced with the most certainty, and preserved indefinitely with little expense, either for human or bovine subsistence, is the best security against dearth or irregularity in the supply of food. There is no crop that can be so safely reckoned upon by farmers as the stalks of cereals, and now we have arrived at a method whereby they can be indefinitely preserved in a condition that is not only nutritive and healthy, but attractive to the taste of all grazing animals, and at the same time it is a method of preservation that is certain and economical. By means of this process the number of cattle that can be supported upon any farm can be as much increased, as the yield of nutritive matter in the stalks of cereals is greater than that in the stalks of the grasses that can be grown upon the same space.

The comparative value of these vegetables will become a matter for discussion, but I have no doubt that it can be easily proven to be twenty times greater. The farmers of Orange county requires six acres for summer and winter support of one cow by hay and grazing, of which seven-twelfths is fed in a dry state. Twenty-five tons of green corn-stalks will support, in better average condition, two cows for a year, with 68 pounds per day. But it is not difficult to double this quantity of stalks per acre. One-half the manure derived from feeding green fodder, carefully preserved, will keep up the land. A mature or fattening animal removes none of the constituents of its food that are valuable for manure. Therefore, the most fertile farms of the Eastern States are, as a rule, those that are devoted to stock or dairy farming. Cattle are not only the distributing reservoirs of vegetation, but they also may be made to increase the sources of supply.

The preservation of green crops in pits called silos has been successfully, continuously, and profitably practiced in France by Auguste Goffart and his disciples since 1873, and in the United States by Francis Morris, of Maryland, since 1876. It is no longer an experiment either as to its practicability nor as to its profit. Either for the mechanic, with a single cow, or for small and large farmers it is proportionately for all a most excellent system of feeding cattle of all sorts, including horses, sheep and hogs.

The United States came very near to being the theatre of this invention. In 1875, Mr. C. W. Mills, of New Jersey, had made an experiment to the extent of fifty acres in hybridizing Southern and Northern corn, by planting them in alternate rows. The result was that the Northern corn ripened first and was removed, while the Southern was still in luxuriant growth, averaging fifteen feet high. Not having heard of Mr. Goffart's discovery, but which had already been reported in the French Agricultural Journals, he did not think to cut it fine, but buried it whole in small

pits on the hillside, six feet deep, with about four feet of dirt over it, trampling it thoroughly. When he opened these pits in March his cattle were furiously hungry for it—sweet, alcoholic and juicy—they chased the cart, and would leave any other food untouched; it was fed out as fast as possible, being drawn up from the trenches with grappling fork and pulley, but of course each trench being entirely open to the air, it soon grew putrid and probably one-third or one-half of each pit was spoiled. The next year, 1876, he did nothing in this direction; but in 1877, still without having heard of Mr. Goffart, or Mr. Morris, he made a complete success, and devised the most simple method of ensilage that has yet been suggested in either country. He made a walled trench in the floor of his barn, or rather underneath it, 40 feet long by 12 feet wide and 17 feet deep, with plastered sides and bottom.

He uses only the Southern Horse Tooth Corn, which grows large and tall, and at its maturity is very sweet. To cut it down he needs a narrow mowing machine with a dropper. To cut it up he has two ensilage cutters, driven by steam power, cutting 4-10 inch; the cut stalks fall directly into the silos, and are spread and trampled by men. The silos are filled about three feet per day, so that the wilting causes much shrinkage; wooden curbing is fitted to the walls, so that sufficient fodder can be piled above them to fill the masonry when it is shrunken, the mass is carefully levelled and the cover is put on, which is two inch plank, tongued and grooved, fitting loosely within the walls, and battened in sections of three to four feet; the battens are put on with screws and project, so that each section is fitted together. This cover is laid directly on the cut stalks, without any hay or straw being used. Sacks of meal are laid upon this cover with care, as to equalizing the pressure, so that it may sink uniformly. Sacks of earth or other weights would do as well, but it is a convenient place to store the meal, which is fed out at the same time. There is not enough steam arising from this mass of cut, green, juicy fodder to stain or moisten the sacks.

In removing for feeding no door is required, as the ensilage is taken from the top by basket and pulley, one section of the cover being removed at a time, without loosening the rest; the perpendicular contents of each section are taken out and put into bins, to remain 24 hours (in winter). The handling is most conveniently done with a hop-fork. When it is first taken out it is as sweet as when it was cut in the field and of a tawny, green color. As the acetic and alcoholic fermentation attack it in the bins it becomes darker in color and hot, so that the hand can hardly be held in it, smoking and vinous flavored, with a slightly acid taste. The cattle, of all kinds, prefer it when in this condition to any food that they are ever permitted to taste. It is possible they might prefer a first-rate muskmelon or a sweet apple, but they would not thrive upon them as they do on good ensilage, even when they have nothing else. One and a half cubic feet for each cow daily (about 70 lbs.) is a full ration for a large animal, or one cubic foot per week for sheep. A silo ten feet wide, ten feet long, and ten feet deep will keep two cows a year, or four cows, if they are pastured half the year. It will hold 20 to 25 tons.

The great variety of food that can be provided for animals under this system is a very useful feature of it. With different silos, not only different kinds of stalks of cereals, but different mixtures, and for that matter different degrees of sourness, if desired, can be provided for the farm-yard table. The experience of three years has satisfied Mr. Mills that he can no longer afford to raise and preserve grass, either by drying or by ensilage, not even clover; and at this time, September, 1880, on his 300 acres, with 100 head of splendid stock, including horses, there is not a pound of hay. He has enlarged his silo to be 80 feet long instead of 40.

He feeds to his milking cows about four quarts per day of meal, half corn, half wheat middlings, or some oatmeal, but no rye.

On some acres in the State of New York, there are ninety tons of stalks, as can be proven by avoirdupois and arithmetic.

Wherever a silo of brick is elevated above the surface, it will be better to bank up around it as a sure protection against heat and cold.

The value of ensilage is undoubtedly greater than that of any green fodder that has not passed through the silo, because it is better adapted and prepared for the digestive organs of the animals. The result is that their stomachs are smaller and they do not have a perpetual diarrhoea.

Salt is not important, except to make it still more palatable. Some people salt their melons, others do not.

The cost of cutting 4-10 inch with a large machine and plenty of power is not more than 25 cents per ton, and there is great economy in making one job of it instead of going to the field and cutting down and hauling a single load at a time, and it is cheaper as well as healthier to cut up the whole crop at one time, put it in silos, and feed it from the silos, even in summer, than to haul it from the field as wanted.

The corn-plant is in perfect condition only a few days to each crop, and it is exceedingly important to cut it at precisely the right stage of growth. I am satisfied that the carelessness of the farming community on this head has caused a great deal of mischief to themselves and to the people that they feed.

The perennial grasses have but little sugar, and can be fed at any time, but better milk, butter and cheese can be made when they are young and juicy than when they are dried; but with cereals, which are annual, there is another law. It is that the dextrine, which largely composes these is alkaloid until it has ripened into sugar, by means of or at the time of tasselling or flowering. This process requires air and sun, and much broadcast corn is fed while unpalatable and unhealthy, both to the animal that eats it and to the human animal that eats and drinks the product.

To ferment the green food before giving it to the cattle, instead of fermenting it in their bellies, is both humane and economical. Dry stalks steamed are not to be compared to this fodder, because the nutritious value has gone into the grain and the sugar has been changed into starch. The error that stood so many years in the path of Mons. Goffart was the idea that there must be a partial dessication. On the contrary, all drying must be avoided. The corn-plant does not remain full of juice more than two weeks after tasselling, and wherever fading has taken place the air has already entered the cells and acetic fermentation has commenced. When cut in that condition the ensilage will be sour, smell like a tan vat, and taste like pickles preserved in manufactured vinegar.

THE EARTH SILO has been more extensively used by Mr. Fraucis Morris than by any one else in this country. His soil in Maryland consists of clay for a foot or two, and a kind of rotten rock beneath. He uses oxen and scraper and makes a trench or pit $5\frac{1}{2}$ feet deep, $7\frac{1}{2}$ feet wide on bottom, and 11 feet wide on top, and any length desired. A width of 11 feet on top prevents danger of arching. At this slope the sides remain firm, and he does not plaster the face. The surface-water is drained from it. In filling it the sides are lined with straw standing, so that the ensilage will slip down, the bottom floored with plank, the top rounded up and covered with a thin layer of long straw, the thinner the better; above that a sheet of tarred roofing felt, and above that the earth is piled on two feet deep. The cut stalks are pounded in and rolled with a heavy roller frequently at first. Vigilance is the price of safety with an earth silo. He has recently built more of them, all radiating from a centre where

the cutter stands, so that he can fill all without moving his machinery. He paid \$260 for his cutter, and can cut ten tons per hour with a six-horse engine.

The stalks are hauled from the field in advance in the morning in order to keep the machine going. He still uses two masonry silos in the stone barn, which were the first pits built for the purpose in this country—those, however, are also covered with dirt and compressed until they have ceased to settle. Mr. Morris thinks very much of ensilage as a forerunner of great wheat crops. He says, "Clover, with its long tap roots drawing sustenance from the subsoil, when plowed under, and barn-yard manure in abundance, will keep land strong for wheat and other exhaustive crops, such as cannot now be raised profitably in the Eastern States.

"The trench should have a shed over it, or a shed thatched with straw. Water should be kept from the cut-up maize, as it would doubtless injure its quality, if not destroy it.

"Maize or Indian corn requires from forty-five to sixty days to ripen it into tassel, and therefore it can be safely sown up to the 15th of July. If the land is in good condition, it will yield twenty tons to the acre; it requires a ton a month for each cow, and all animals will improve and do well upon it. By the use of superphosphates the crop can be doubled, but this is a matter subject to the will of the farmer. Ten acres of maize will feed thirty cows during the season that they cannot feed out of doors, and will furnish a quantity of manure to give a wheat or corn crop. The advantage of this crop is so great that it must change the agriculture of every corn-growing country. Cattle and sheep will be raised on every farm to an extent heretofore not thought of. Wheat, to-day, by all our best farmers, is followed by clover, the clover is cut and made into hay, and this is fed to the stock. Maize will take the place of clover hay, and the clover will be grazed off the land, and the animals will return it to the land better prepared to act as a manure than if the clover was cut, made into hay, carried to the barn, and then fed to the stock. The advantage of grazing clover off the land is very great, as it at once returns to it all that the clover takes from the sod.

"I recommend every farmer who reads these suggestions to sow an acre of land with corn or maize—if you have no drill sow it broadcast, and when in tassel use any old mowing machine you may have to cut it down, and then if you have no feed-cutter, buy or borrow one and cut up the fodder as ordered—bury it in the ground, and when winter comes feed your stock upon it, and when you try it once you will never be without it again. I have used it for four seasons, every time with complete success, and I know that it multiplied the value of our land three or four times over."

But in competition with the great tenant-farms of Minnesota, California, etc., the grain producer of the Eastern States cannot thrive as such against such a combination of capital, machinery, and space. On the stock farm, however, this combination has no especial advantage where ensilage annihilates winter for the dairyman.

The manure heaps in the cattle-yard should be made sloping, so that it can be driven upon, and by compacting it can be kept from heating. This is ensilage of the manure heap.

MASONRY SILOS.—For several years past Mr. O. B. Potter of Sing Sing has been using underground brick silos. These are arched over and are provided with manholes or necks through which the cut fodder is thrown into the pit below. It is then trampled and covered with earth or brewers' grains. As it is not compressed by continuous pressure of 50 to 100 pounds per square foot the air is not entirely expelled and the ensilage is always sour. Mr. Potter says however that his cattle do well upon it. The silos are connected with each other by narrow openings making a succession

of chambers, and also with a passage to the stable so that all the food and the labor of supplying it to the animals is out of sight and out of the way of the landscape above. The walls are 12 inches thick, brick laid in cement with smooth joints, and when the ground is gravelly or sandy the outside is covered with a coat of cement. The bottoms are laid with brick flat in cement.

I do not dwell upon the method of filling and watching for cracks in the earth covering, because few will be likely to follow this method on account of the expense and the awkwardness of filling under an arched roof, but Mr. Potter is as enthusiastic as the others. He seems to have been bitten by the same dog; he says:

MIXING FODDER IN THE PITS.

"Much advantage will be gained by mixing clover and grass in which clover predominates in the same pit through fodder corn, millet or sorghum. The clover becomes after the first fermentation a putty like mass, which fills the interstices in coarser and more fibrous fodder, and thus makes the whole much more compact and weighty than it would otherwise be, while it improves the quality of the food.

"Among all our products in the Northern States there is none which will be more enhanced in value by this system than red clover. By it this is rendered the most profitable and most easily preserved without detriment of all our grasses. A well built up with an 8-inch brick wall in cement, 12 feet in diameter, 30 feet deep, with a roof, windlass and bucket, will preserve perfectly and deliver for use the whole clover product of more than twenty acres of fertile land. I have recently put the fairly heavy clover from sixteen acres into a space 24 feet long 13 feet wide and 10 feet deep. But the benefit of this system when applied throughout the country in preserving fodder corn, sorghum, and the large millets will be incalculable. These crops, hitherto the most difficult, uncertain and expensive to cure and preserve, become the surest, easiest and least expensive in these respects, while they are among the richest and best milk and butter producing foods known. By this system the whole southern portion of our country where the tame grasses are not grown is at once furnished with a means everywhere applicable and easily practicable by which their cattle may be fed and fattened in winter and summer as well, and nearly or quite as cheaply as where tame grasses abound. Who shall say how important an agency corn, sorghum and clover wells and pits, which will be practically everlasting and will save two-thirds the labor and all the waste in curing and preserving these crops, too safely to require insurance, and in one-twentieth of the present space, may not yet have in making this land of liberty, union and progress also a land flowing with milk and honey for this and future generations?"

CONCRETE SILOS.—Where the land is of such a nature that deep silos cannot be dug in it and made dry with economy, the next best thing is a concrete silo.

The first silo of this kind built in the United States is that of Dr. J. M. Bailey, at Billerica, Mass., who was so thoroughly inspired by reading Monsieur Goffart's story, even through the spectacles of my translation that he immediately undertook it. He has contributed very much to the public confidence in the system by his energy in practicing it, and activity in writing about it. He says, "my silos, 40 feet long, each 12 feet wide and 16 feet deep, capacity about 800,000 pounds, cost me \$500 or about one dollar and twenty-five cents per ton of capacity, larger ones would cost less."

He recommends an earth box 12 in. by 15 in. high for weights to compress with. He seems to think a shredding machine might do better than a cutter, but in that

he is certainly mistaken. The cutter advertised in this book combines all the important features—strength, rapidity, clearing freely without clogging, positive feeding and with expansive rollers and simplicity of parts. It has been used four years for this purpose by the largest ensilagist in the world at present, and it is entirely unnecessary for the Doctor to be experimenting in that direction, at any rate until he has seen this one.

His cost from field to silo was about 75 cents per ton. On a larger scale it can be done for half that amount. He claims for the system of ensilage, that "milk can be produced for one cent per quart, butter for ten cents per pound, beef for four cents per pound, mutton for nothing if wool is thirty cents per pound."

From the *Country Gentleman* I extract the following directions for building concrete silos, written by Mr. E. W. Stewart, of Lake View, New York, who is a perfect well-spring of practical information in agricultural affairs:

"For a silo 12 feet by 20 feet (or longer) and 14 feet deep, which would hold 72 tons, or sufficient for 10 cows 6 months with full rations, the concrete walls should be 14 inches thick at the bottom and 10 inches thick at the top of the side walls, with the bevel on the outside of the wall, and the end walls 12 inches thick top and bottom, the inside being perpendicular and smooth, so that the plank covering may settle with the ensilage. The concrete wall is stronger than an ordinary stone wall, and for this short silo, 14 inches at bottom is thick enough. It is not best to go any deeper in the earth than can be well drained, and a trench should be cut on the outside of the wall, 6 to 10 inches deep, all around, to carry off all water that may reach this depth. If the land around the silo is nearly level, it is best to go only so deep that the bottom of the wall will be below frost.

"Having excavated the earth as deep as the wall is to go, 15 feet wide and 23 feet long, then set the standards for the boxes to form the concrete walls in. It will require 20 standards 3 by 6 inches, 15 feet long (if the walls are to be 14 feet high), of straight grained timber. Those standards intended for the inside of the wall should be jointed straight on one edge, so that the wall may be made very straight and plumb on the inside. There will be three standards upon each long side—one at each corner and one in the middle. The outer edges of these inside standards will be 11 feet 9 inches apart, and as the boxing plank are $1\frac{1}{2}$ inches thick, this will bring the walls just 12 feet apart. The outside standards will be opposite the inside ones, and just 3 inches farther apart than the wall is thick, so that when the plank are placed inside it forms a box 14 inches wide at the bottom, and the bevel or slant on the outside of the wall is made by bringing the outside standard 4 inches nearer the inside standard at the top. The end standards will be parallel with each other, and 15 inches apart. These standards are held together by nailing a lath under the bottom end and a bracket across the top end, holding the side standards 17 inches apart at the bottom and 13 inches at top. Then, when the standards are set up, and the inside standard plumbed very carefully, and both stay-lathed to hold them firmly in position, and the standards placed all around the proposed silo, it is all ready for fitting in the boxing plank. These boxing plank should be straight-grained hemlock or pine, 14 inches wide, $1\frac{1}{2}$ inches thick, and may be the whole length of each side and end, or, if more convenient, the sides may be two planks long, and the outside end plank will require to be $14\frac{1}{2}$ feet long, but they may run by the ends of the side planks. The outside of the ends must be plumb, so that the outside plank of the long sides can be raised, but the end walls being shorter, 12 inches thick is enough for strength, and has the same material per foot of surface. When these boxing planks

are placed, there will be a continuous box, 14 inches on the sides and 12 inches on the ends, around the silo.

PREPARING THE CONCRETE.

"Water lime concrete is the only concrete suitable for silos, as it requires a strong, air-tight, smooth wall, and one that can stand moisture to some extent. This kind of wall is easily made air-tight, and is built cheaper than an ordinary stone wall. It is only necessary to use water lime or cement enough to completely coat the particles of sand, so as to cement them together, and this becomes a cement to fill in spaces among large gravel or between stones. The cement is made by mixing one part of water lime with four of fine sand, while dry, so that the lime and sand can be evenly mixed. Then work it into mortar, and if you have coarse gravel and no stone you may put in five or six parts of gravel, and this will be sufficient to cement all together. The gravel is best mixed in the mortar bed, but it must be used at once, as such mortar sets in a few minutes after wetting. But if you have rough stones of any kind, cobble or flat stone, they can be worked into the wall to good advantage, and save cement. When stones are to be worked in, put one or two inches of thin mortar in the wall box, then bed into this mortar a layer of stone, keeping the stone back a half inch from the boxing plank, so that the cement may be tamped all around the stone, leaving a smooth surface on both sides of the wall. This cement is a poorer conductor of heat, cold and moisture than stone. A properly built concrete wall never shows frost on the inside. In many parts of the country, thin, flat, irregular stones are found in abundance, and these are well adapted to concrete walls, it requiring only a thin layer of concrete mortar between them, and the wall becomes solid in a few days. But with these flat stones, it is better not to bring them quite to the boxing plank, but to let the concrete come over the edges so as to form a smooth surface.

"When this concrete wall is laid with stone, sand and lime, as stated, so large a proportion of stone may be worked in that the water lime will be only one-tenth of the wall, and the same when the wall is made of sand and coarse gravel; so that, to find the amount of water lime required, count one barrel to 40 cubic feet of wall to be built. If water lime is very expensive, and you have flat stones, no matter how irregular, you may use quicklime after you get one foot higher than the earth will come against it. One of quicklime to five of sand will make an excellent mortar to lay these stones in, doing the work in all respects as above stated. The concrete should be well tamped into the boxes, filling all crevices between the stones, and solid against the planks. Water lime will set hard enough so that these boxing planks can be raised 12 inches every day. That is, if you fill the box all around the silo in one day, the next morning you may raise the boxing planks where you began the day before; and as you fill, raise section after section of planks till you get around again. This you may repeat each day till the wall is completed, provided the mortar sets in the usual time. But if quicklime is used, this sets slower, and will take two or three days to become strong enough to raise the planks. It will be noted that the planks are 14 inches wide, but are raised only 12 inches, which leaves a lap of 2 inches on the wall below, keeping the sides of the wall smooth and even. The proposed silo wall will have 952 cubic feet in it, and requires 22 barrels of water lime, of the Akron or Rosendale brand. This lime in many places will cost from \$1 to \$1.25 per barrel or \$22 to \$27.50. The only other cost of the wall is the labor, which can be done by common laborers. The standards can be set by any one who can use a level and plumb. When the walls are completed, take a seasoned board as wide as the wall

is thick, tar one side and turn the tarred side down upon the wall. This will prevent the moisture from rotting the plate rim placed on top of the wall.

"The roof placed over this silo must be elevated some 3 feet above the plates so as to give head-room for filling the silo full. This may be done by framing short posts into the timber on top of the wall, and placing light plates on these, upon which the roof is to stand. It will be seen that this silo can be built, by many farmers, with only a small expenditure for water lime, shingles and nails, all the rest of the materials being from their own farms. The bottom of the silo is usually cemented, to prevent moisture from rising from below. I believe the silo is to be generally used in the future for storing green food for winter feeding."

Mr. Stewart has also written some valuable articles on *Dairy Buildings*, from which I extract:

THE OCTAGON BARN.

"This form is most admirably adapted for enclosing the greatest space within the shortest line of outside wall, and is as easily and cheaply made as the rectangle. A little examination of this form of barn will not only show its adaptation to large farms but to all sizes—from the smallest to the largest. A farmer has but to calculate how much room he wants for cattle, how much for horses, how much for sheep, how much for hay and grain, how much for carriages, wagons, tools, or any other purpose, and he can enclose just the number of square feet needed, and with the shortest outside wall. He may be liberal in his allowance of room, for it costs less, in proportion, as the size is increased. Suppose he requires for a fifty-acre farm, 2,090 square feet of room; this would require a fifty-foot octagon or a 40x52 rectangle. Now he would require timber forty feet long for the latter, while he could build the octagon with timber for the sills and plates only twenty-two feet long, and this would be the longest timber, unless he wished his posts higher. Each side would be only $20\frac{2}{3}$ feet, and the wall for the basement 165 feet long, whilst the other would be 184 feet long, saving 19 feet of wall and siding by the octagon, requiring but eight corner posts, and no intermediates, as the girts would be less than twenty feet long. He would require no interior posts or beams, except those for scaffolds. All the ordinary purlin posts and beams would be saved, and the labor on them. It is easy, also, to see that a few feet added to each side would furnish room for another fifty acres, and so on to any size desired. This form of building, properly understood, would lead farmers to abandon the building of a separate barn for each specific purpose, and to providing for all their necessities under one roof. If several barns are placed so as to be convenient, the danger, in case of a fire, is about the same as in one barn, for all would burn in either case. The economy of roofage is exhibited strongly by a comparison of my four barns with the octagon that takes their place. One hundred thousand shingles were required to roof the former, while sixty thousand covered the octagon.

"This barn, 80 feet diameter, enclosing 5,350 square feet, has a much greater capacity than the four barns which covered about 7,000 feet. Its extended form being that of an octagonal cone, each side bears equally upon every other side, and it has great strength without any cross-ties or beams, while the roof boards act as a powerful tie to hold it all together, each nail holding to the extent of its strength, thus supplementing the strength of the plate rim or bottom chord. The octagonal roof of one-third pitch is self-supporting, resting only on the outside plates, and may be safely stretched over a diameter of as much as 150 feet without posts or purlins.

SELF-CLEANING STABLE.

"Automatic platforms, by which the stable may be made to clean itself, can be made. He has had one in operation for more than two years. Not five minutes of time have been expended in his stables in two years in cleaning. Let the fore feet of the cattle stand on a wooden platform and their hind feet upon an iron grating, made of wrought iron bars three-eighths of an inch thick and one and one-half inches wide. The bars of the grates are placed one and five-eighths inches apart, and rest upon iron joists one-half inch by two, these resting on an angle iron eill at the back of the platform, and the other end resting on the wooden platform. Through this grating the droppings fall. Harris Lewis once said, "cows cannot be kept clean unless you set up all night with them." This plan sets up with them and keeps them perfectly clean. There must be a receptacle below the grate, which must be cleaned when filled; but this cleaning is no more labor than when the manure is thrown out into a pile. Gratings can be put in for about six dollars per cow and will last a life-time.

"The cattle stand upon these bars with ease. Their feet stand across the bars. The gratings cannot be used in barns in which the manure freezes. No wood work comes in contact with the manure, and therefore there is no wood to be rotted. If winter dairying is to be inaugurated, cows must be kept clean. The platform costs no more than the bedding of a cow for one season.

"This platform saves all the liquid as well as solid manure in the gutters under the platform. This saving of the liquid manure is equal to the whole cost of the grating in a single year. In Flanders the liquid manure of a cow is estimated at \$10 per year.

COLD STORAGE.

"The cheapest store room for dairy purposes is to go down into the earth for it. The right temperature can be reached anywhere by going down fifteen feet, walling the excavation and covering it. It is not to be recommended for setting milk, but for ordinary cold storage it is valuable. It would not be so easily cleansed as a room above ground, and therefore would not be so convenient for setting milk, but a temperature of sixty degrees or under, may be reached at fifteen feet, which temperature will be even, and therefore better for storing butter, or even meat for short periods, than in an ice house. For such purposes this excavated room would be cheaper than in any other form. It would furnish an excellent temperature for ripening cream. It might be made very useful in the Southern States, where a high temperature is so destructive to dairy products."

HOW TO RAISE FODDER CORN.

FROM A LONG ISLAND FARMER.

"THIS very important and valuable crop needs only to be well managed and a fine yield is insured. I have had fine results without fail under the following treatment: Having the ground thoroughly pulverized before planting and a proper cultivation after the corn is up, will change results in this, perhaps as much as any crop the farmer grows. Sward ground may be considered as good a chance for this crop as

it can have. I plow the ground in the fall (being a firm believer in fall plowing for other crops as well), and always plow about nine inches deep; this I do with an Adamant plow, the only plow I ever saw that would turn a furrow that depth satisfactorily. Deep plowing will tell its own story in any fair soil. (See cut beyond.)

"In the spring or early summer, my first object is to thoroughly pulverize the soil as deep as possible without tearing up the sward; this is effectually and quickly done with a disk harrow, one of the best implements that I ever saw. It leaves the soil more mellow, loose and light, than it is possible to get it with any other harrow. No good farmer would be without one of these tools after seeing it work one half hour.

"If it is desired to use stable manure (and for mellow ground I think this preferable in connection with a 60 bushel to the acre coat of shell lime), which may be spread broadcast and thoroughly worked and mixed with the soil by this same wheel harrow. But sward ground may be considered a fine chance without fertilizer; all that is required is something to give the corn a start, and guano seems to fill the bill for this purpose better than anything I ever tried, and is as quickly applied. I then sow the corn in rows or drills about thirty inches apart with a grain drill. Two bushels and four quarts I consider the proper quantity to the acre. Those not having a regular grain drill can use a rotary seed drill, sowing perfectly one row at a time with one horse; this drill only costs about twenty dollars and can be adjusted for sowing any seed, however small or large, without skipping. (See cut beyond).

"After the corn has attained the height of about an inch the smoothing harrow is applied, and I continue harrowing every few days in this way the whole ground over until the corn has attained a height of three or four inches. The result is that a whole crop of weeds just sprouting are destroyed at each harrowing, saving an endless amount of labor afterward, and also leaving the ground loose and mellow at the surface. From the peculiar construction of this harrow it does not pull up or injure the corn in the least; the teeth are round and small and set at an angle of about 30 degrees, sloping backward; and the draft being applied at an angle gives the teeth a sort of zigzag movement, completely stirring up every inch of ground. The growing corn being sufficiently strong dodges the teeth and is not injured. This harrow is admirably adapted to harrowing potato fields, before and after the tubers are above ground; also for smoothing the ground for seed of all kinds. It leaves the ground in much the same condition that it is after being raked with a steel tooth rake. As the corn becomes too large to permit of harrowing in this way, I cultivate between the rows."

For heavy soil a plow running deep, such as the *Cabbage Adamant* (see cut beyond), will largely increase the size of the stalks. For light soils the *Hilling Cultivator* (see cut beyond), will accomplish excellent work in killing weeds.

Some farmers say that it is a mistake to sow or drill it too thick, and that three pecks of Southern Horse Tooth Corn is sufficient and makes more nutritive stalks. Of course, the better the soil the less seed will be required.

THE COW PEA

is much more valuable food for ensilaging than fodder corn, each ton of it having much more nutrient. It is much nearer a complete food in itself, having a proper proportion of albuminoids to carbohydrates. Fodder corn has a great value on account of the facility of raising it all over the country, and also from the fact that more tons of corn can be raised upon an acre than of any other crop. There is little doubt that when the system of ensilage shall become common, the green food pre-

served will be composed of a variety of crops—such as cow peas, or other peas, and fodder corn, clover and fodder corn, green rye, millet or Hungarian grass, peas and oats, grown together, and in fact, all grasses. The Southern States will be particularly adapted to this system.

Dr. Wolff gives the value of average hay at 64 cents per 100 pounds. Ensilaged corn fodder, containing 80 per cent. of water, according to the most careful experiments I have been able to make, is worth one-half as much as good hay. This makes the corn-fodder thus prepared worth, on the same basis, 32 cents per 100 pounds. Dr. Wolff also gives the value of corn as \$1.10 per 100 pounds. Prof. Johnson gives the value of corn meal as \$1.04 per 100 pounds; therefore a barrel of corn would be worth, according to the German chemist, \$3.08. By dividing \$3.08 by 32 cents, the value of the corn fodder, we have almost 963 pounds as the amount of green corn fodder (properly preserved), which is the equivalent of a barrel of corn. By computing it according to the valuation of corn meal by Prof. Johnson, we find that 910 pounds of ensilaged corn-fodder is equal to a barrel of corn ground into meal.

Ensilage is not likely to become a portable commodity by baling; though decay takes place very slowly when packed solidly, still a bale would soon be surrounded by a few inches of decayed and maggoty matter.

LETTER FROM M. AUGUSTE GOFFART.

To MONSIEUR J. B. BROWN AT NEW YORK.

December 19, 1879.

"BY your letter of Nov. 19th I am informed that you are to deliver a lecture to the American Dairyman's Association, on the "Ensilage of Maize," and you ask what modifications of my processes I may have adopted that may profit your fellow-citizens.

"The longer experience I have in feeding ensilage to stock the more I am convinced of the great service that it will render to agriculture.

"From October, 1878 to October, 1879, I have fed the hundred animals in my stable exclusively with ensilage maize during the winter, and concurrently with fresh maize at the time when I had it. The animals have always enjoyed the most excellent health, and I can assure you that they have more appetite for the ensilage maize than for fresh fodder, whatever kind it may be. Cows fed upon fresh maize give excellent milk, which yields first quality butter and of exquisite flavor. Fed upon ensilaged maize, the milk is still very good, and I have not noticed that its quantity diminished, but the butter, while still being of good quality, is however inferior. But whatever may be the diet of the cows in winter, the butter made at that season is always inferior to that made during the fine weather. I have caused to be taken from the account books of the expenses upon my Domaine the cost of the culture and ensilage of maize during the past season. I hope to be useful to you in sending it herewith. You will observe how small a cost for the food of the animals. Indeed, in reckoning 6 per cent., the weight of the animal for its daily food, I arrive at an expense of 3 $\frac{1}{2}$ of a cent per day to feed an animal of 1,320 pounds. I know of no fodder of which the ration costs so little as my maize, which only costs me 90 cents per ton; and this notwithstanding the year has been unfavorable for maize, the wet spring and part of summer having injured the plant. I have built near my

silos an embankment, forming a platform, accessible from two sides by a gentle slope, for the easy ascent of carts loaded with maize. Upon this platform I have established an engine, and my stalk-cutter, which are level with the upper part of my silos. The elevator carries the fodder over the center of the middle of one of the three silos, and it falls into all the silos in diverging streams. I have obtained thus a noteworthy economy, by avoiding moving the machines, and by saving valuable time at a season of the year when the working days are so short.

"I thank you for the kind words you have sent me. I consider them as a recompense for the efforts that I have made for so long a time to make myself useful to agriculturists. I trust that your fellow-countrymen will be glad to enter in the path which you have indicated to them. Say to them that those of them who desire to come to study the subject of ensilage upon the ground, may rest assured of receiving a kind reception at Burtin."

DOMAINE OF BURTIN.

Account of crop of maize, 1879, 75 acres :

30 days	150 days, horses at 93 cents.....	\$139 50
	453 days, men at 56 cents	253 68
	408 days, women at 37 cents.....	150 96
		<hr/>
		\$544 14

Commenced September 29. Finished November 8. Total crop, 2,376 tons. Of which fed green, 53 tons.

Account of cultivation and ensilage of $2\frac{47}{60}$ acres of maize = one hectare :

Deep fall plowing.....	\$4 09
Harrowing	57
Spring plowing.....	4 09
Harrowing	57
Manure, 64 feet at 16 cents, \$10.26; cartage, loading, spreading, \$2.40.	
Total, \$12.64. Charge one-half to this crop.....	6 32
Guano, 440 pounds, at $2\frac{1}{2}$ cents.....	12 76
Seed, 220 pounds, at $2\frac{1}{2}$ cents	5 80
Sowing broadcast.....	18
Plowing in seed.....	2 23
Harrowing	57
Cutting with sickle.....	5 02
Loading on wagon	2 79
Carting.....	4 65
Cutting	2 79
Filling.....	93
Covering (silo containing 600 tons).....	25
Wine to employees, 20 quarts at 10 cents.....	2 00
Use of engine and cutter	1 86
Wood for fuel.....	1 86
Oil for machinery.....	19
Fireman.....	85
Rent of ground	5 58
Interest one year, at 5 per cent. on above expenses.....	3 30

\$69 25

Total cost, ready to be fed, $87\frac{1}{2}$ cents per ton, or \$28.03 per acre.

SCIENCE AT THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

New Haven, Conn., July 1, 1880.

"THE smaller amount of dry substance, both in acreage and in equal weight, in case of the thickly sown corn, is very striking. Thick planting, early cutting or immaturity and heavy manuring, all act alike in increasing the water content of fodder corn.

"That the silo cannot create any fodder, or that we cannot take out of the silo any food element that we do not put in, is evident.

"It is, I scarcely doubt, equally true that ensilage is no more palatable, no more digestible, and no more nutritious than the fresh corn from which it is produced. The rumor now floating in the air that ensilage is worth more, nay, much more than the fresh corn fodder, has nothing solid to rest on. Fodder is on all hands conceded to lose nothing in the silo that can effect a concentration of its nutritive matters. The analyses of Barral, which Goffart quotes in his book, give both for fresh maize and for ensilage 80 per cent. of water. The main advantage of the silo plainly is to magazine green fodder. Whether in our climate the silo or the stock and shed are best, experience must decide. Whether successful ensilage is more palatable or more cheap than well cured corn fodder, experience must likewise settle. That ensilage, once provided, may be a valuable accessory to dry feed, is fairly to be anticipated, but evidently the enthusiasts are overrating it."

S. W. JOHNSON.

The New York Legislature has recently appropriated \$20,000 a year for the support of an Experiment Station. If Dr. Heath manages it, it will be practical and useful to the community.

ESTIMATED ACCOUNT OF 50-ACRE FARM, BY J. M. BAILEY, OF WINNING FARM.
15 Cows, WITHOUT ENSILAGE.

Expenditure.

Interest on farm, value \$5,000.....	\$300 00
Repairs on building, $2\frac{1}{2}$ per cent. on \$2,000.....	50 00
Taxes on farm, \$40; on stock, \$10.....	50 00
Wages and board of hired man, 9 months at \$30.....	270 00
Depreciation of stock and farming tools, \$1,500 at 10 per cent.....	150 00
	<hr/>
	\$910 00

Income.

2,000 quarts milk per cow at 3 cents.....	900 00
Deficiency.....	\$10 00

Showing that the farmer and his wife work for their board and lose \$10 per year.

SAME FARM WITH ENSILAGE. 28 Cows, 100 SHEEP, 7 HOGS.

Interest on farm, stock, silos, manure and sheep-shed	\$561 70
Wages one hired man, 6 months at \$25.....	150 00
Repairs.....	50 00
Taxes and insurance	80 00
Meal and bran, 4 pounds per cow, per day.....	280 00
Grain for sheep and horses.....	150 00
	<hr/>
	\$1,271 70

Income.

5,600 pounds butter at 10 cents	\$560 00
14,000 pounds pork at 3 cents	420 00
28 yearlings at \$10	280 00
700 pounds wool at 30 cents	210 00
90 lambs (Cotswold) at \$4	360 00
	—————
	\$1,830 00
Profit	\$558 30

COMPARATIVE COST.

The expense of keeping 35 horned animals and 100 sheep at Winning Farm, is as follows:

1,350 pounds of ensilage at \$1.01	\$1 35
90 pounds of shorts	80
50 pounds of hay at \$15.00 per ton	37½
Total cost per day	\$2 52½

The cost of keeping the above stock upon hay and grain would be as follows:

20 pounds of hay to each animal (ten yearlings counted as five cows), making 30 head, would require daily as follows:

600 pounds of hay for cattle at \$15 per ton	\$ 4 50
200 pounds of hay for 100 sheep	1 50
120 pounds of shorts for cattle at \$18 per ton	1 08
46 pounds of shorts for sheep	36
Total cost of keeping 30 cattle and 100 sheep per day on hay and grain	\$7 44
Cost of keeping the above on ensilage as above	2 52½
Daily balance in favor of ensilage	\$4 91½

Dr. Bailey says: "From my experience in feeding so far, I consider Ensilage to be worth one-half as much as the best timothy hay. I would not, however, exchange Ensilage for hay and give two tons for one."

FARMING FOR PROFIT.

THE most profitable farming is that which gives the largest returns for the smallest comparative outlay. This statement is based on business principles, but it is not always apparently true, for sometimes a farmer gets large crops with small outlay by the use of means which draw heavily upon the reserve forces of the soil. The latter should be reckoned into the expense account, but usually is not, though if such a course is continued, it results in exhaustion. To revise the first statement then: that kind of farming is most profitable which gives the largest returns for the expense incurred, without decreasing one's capital by exhausting the soil.

English agriculture dates its rise from the beginning of the fattening of animals for market. The most fertile farms in the Eastern States to-day, are, as a rule, those that are devoted to stock and dairy-farming. The production and sale of large crops of grain, potatoes, and other field crops, without any return of fertility, has caused the present sterility of the many thousand acres of comparatively exhausted farm lands, West, South, and East. If their owners had kept live stock for the consumption of the crops, and sold only the animal products and the surplus grain, etc., they might have been even more productive to-day than in the beginning. The growth of plants does not exhaust the soil, but on the contrary makes it richer, so long as the mineral and nitrogenous elements of plant-food are returned to the land. The action of the roots is to extract food material from the rocks (as we may regard the inorganic matter of the soil), and of the leaves to draw it from the air, and to store it in the soil; but if more than the material thus obtained is removed and not returned, exhaustion necessarily follows.

By feeding crops to animals, the larger portion of the essential mineral and nitrogenous portions are returned to the soil in the resulting manure; particularly is this the case in fattening mature animals, and in the production of butter and pork. An animal extracts from its food nitrogen for its muscles, phosphate for its bones, some potash, and the vegetable oils and other carbonaceous matter for its fatty tissues and for respiration. The nitrogen, phosphates and potash, we must supply to the soil, as plants seldom obtain these materials from natural sources so rapidly as we remove them in crops sold; the material for oils, sugar, starch, and other carbonaceous matters are furnished to the plants from air and soil in ample quantities to meet all demands. Now, a growing animal stores up the first three of these food materials. A mature animal, on the contrary, only uses enough of them to make good the wastes of the body, but these wastes are all found in the excrements; so that practically a fattening animal removes *none* of those constituents of its food that are valuable for manure. We can, therefore, feed the home-grown crops and purchased food to mature animals, and get nearly or quite its full value twice over in beef, and in manure for the production of more crops.

Similar principles apply in feeding swine. Pork is for the most part composed of the fatty matter which costs nothing in the crop. Hence the value of hog manure, with which every farmer is familiar. In butter-making also, very little if any fertility is removed from the farm in the butter sold, as it is composed wholly of fatty compounds. This fact is illustrated in practice by the exceptional fertility of butter dairy farms, which, instead of becoming sterile are continually growing more fertile. These facts indicate that the profitable farming of the future in many sections is to be, as it is to-day, in increased attention to fattening animals and in dairying.—*From American Agriculturist, Jan., 1879.*

CONCLUSIONS.

After much investigation into this subject, I have come to the conclusion that this system must prevail, and that the method of making hay and drying stalks is soon to be abandoned, and that when the ensilage is properly preserved from ripe stalks (not ripe with grain) just as good and just as much milk and butter can be made in the winter as in the summer, even in the climate of the Northern States.

Mr. Mills' method is certainly the best yet described. He says, "The silo should be of such size as that the facilities for cutting may be able to fill it in three days. The curbing should be about one-third of the depth of the silo, and when filled the battened two inch oak plank sections should be evenly and solidly laid, so that as the mass settles, the cover will come right between the masonry walls. These sections of three and one-half feet are equivalent to separate pits, since the air cannot enter

the side on account of the compression, and the space under each section can be entirely emptied, and the quantity it contains used up before disturbing another section. If this cover were not battened it would not be so firm and even. It is not to be forgotten that the cover is to be put on as soon as the filling is completed. No muriate of soda (salt) should be used with this alcoholized food. Nothing as yet known is as profitable as maize, but under the high manuring that is to come from this system, there is no telling to what extent other forage plants may be profitably grown. A door to a silo is to be avoided if possible; the method of emptying from the top being so much better.

And now a word about plowing; much of the land in the Eastern States is practically exhausted. It has been borrowed from without return many years, scoured with crops, and forced with lime, and plowed at same depth, not exceeding six inches. In many places the soil below this depth is better than that above it, and it has become cemented or puddled by plowing at a uniform depth, without subsoiling, so that roots cannot penetrate below in search of moisture and fertility. Almost all the sub-soil plows advertised have been too easily broken, or lift too much soil. Cut herewith, illustrates one that cannot be broken and which breaks without lifting.

To return to the great subject, the best testimony that I have heard was from a farmer, whose silo was emptied April 1st. He said it cost him more to feed his eighty cows from that time to pasture in May, than the whole five previous months had cost. He has enlarged his silo, and the accident will not probably occur again with him.

It is of the greatest importance that the Machinery should be strong. A Farm Engine is steadier and safer than a tread Horse Power, but if the latter is used it is very important to have a Governor on it.

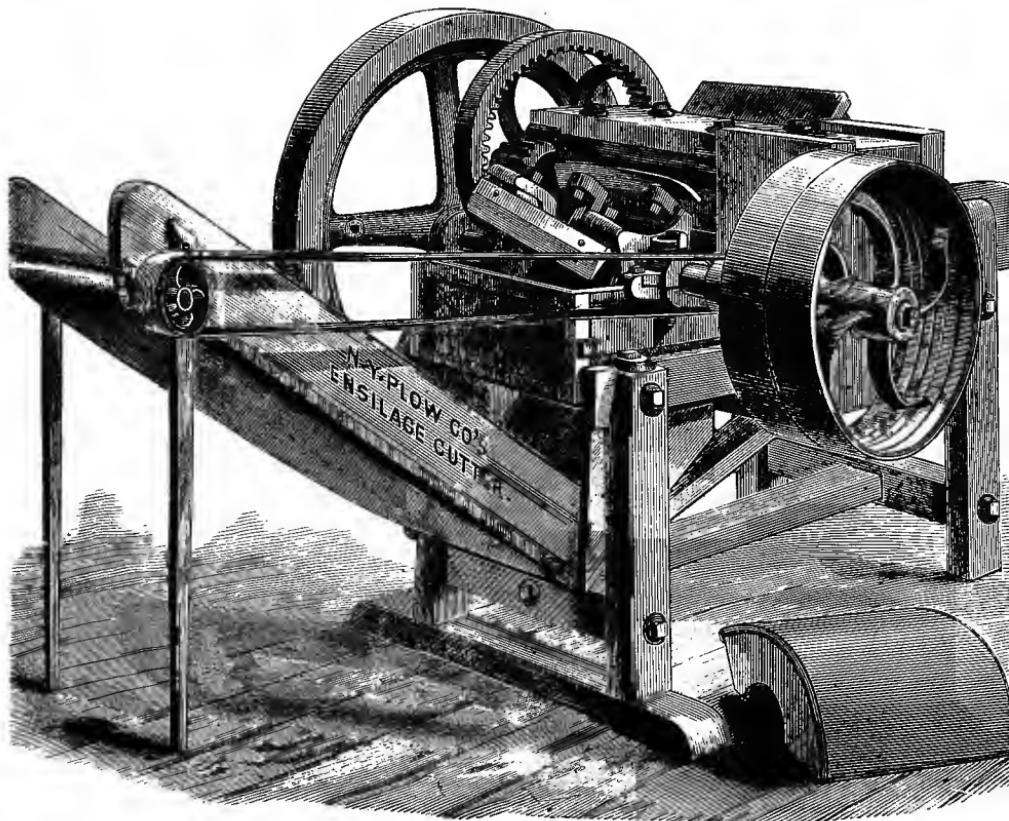
The Cutter cannot be too strong, and must run smooth and true. Many farmers will have their first effort in this system sour in the silo through delay, caused by the breakage of their Cutter, when, through inexperience, they have bought too light a machine for the purpose. It requires watchfulness and frequent oiling. It is a good plan to have a reserve Cutter, but at any rate duplicate parts should be on hand before commencing operations. Care is the only preventive of breakage. A Slipping Balance Wheel, sometimes recommended, cannot reduce in any way the force of the blow, and is actually a disadvantage.

But Farmers should not be deterred from adopting this system by the apparent cost. Any cellar or old ice-house or any place in which pressure can be applied and air tight and water tight sides be made will do for the first investment.

A one horse Lever or Tread power with such cutters as have been used for cutting dry fodder until the profits of the system will provide a larger one, is better than to do nothing. Such a power is competent to 10 to 15 tons of green stalks per day and can be used with a light animal with very little risk.

An Alderney bull trained from yonth will make a useful animal for a tread power.

On land where there are many loose stones great care should be taken that none get mixed with the stalks, as the Cutter is always liable to breakage from stones. A movable low platform on wide wheels to lay the stalks upon as cut is safer than to throw them upon the ground, and is easier to load from. In unloading a wagon much labor and time can be saved by placing two ropes lengthwise on the bottom of the wagon, the front ends joined in a ring, the rear ends provided with a ring in each ~~two~~ hook over two hooks screwed in the floor of the barn or platform. The wagon being backed to the door, the front ring is raised and attached to a pulley rope and by a double pulley or windlass the whole load can be at once rolled over and upon the platform by the side of the Cutter. If not already built the silo should be begun as soon as the crop is planted and the Cutter should be obtained and ~~set~~ in position weeks before it is time to use it. If these things are postponed the harvest will be delayed till the stalks become pithy and the leaves faded.



ENSILAGE CUTTER:

(Trade Mark of The N. Y. Plow Company.)

Combines great rapidity with strength, durability and simplicity of parts. It has 4 spiral knives of heavy cast steel. The length of cut is easily changed. The two feed rollers open both parallel and obliquely, and cannot be clogged. The knife cylinder revolves without jar, and cuts with exactness. The mouthpiece is of hard steel, with its cutting edge planed; the knives cut *upward* which is essential to safety. Nos. 2 and 3 have tight and loose belt pulleys and babbitted boxes.

We have made a special study of cutters for ensilage, and claim to know about them.

No. 1. —Has 4 knives, weight 600 lbs. Length of knives, 12 in., cuts, $\frac{4}{5}$, $\frac{5}{6}$, in. Weight of balance wheel, 125 lbs. Diam. pulley, 18 in. Will cut $1\frac{1}{2}$ tons dry or 3 tons green stalks per hour. Suitable for 1 horse power. Price.....	\$75 00
No. 2. —Length of knives, 15 in. Length of cut, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{6}$, $1\frac{2}{5}$ in. Diam. pulleys, 22 in. Weight of balance wheel, 150 lbs. Will cut 2 tons dry or 5 tons green stalks per hour. Price.....	\$120 00
No. 3. —Length of knives, 18 in. Length of cut, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$, $1\frac{2}{5}$ in. Weight of balance wheel, 400 lbs. Diam. pulleys, 26 in. Will cut 4 tons dry or 10 tons green stalks per hour. This cutter is now in use by the largest ensilagist in the United States. Price.....	\$250 00
Extra for Elevator.....	\$15.00
Smaller Cutters for power.....	\$25, \$40 & \$60
“ “ “ hand.....	\$7, \$9, \$15, \$20 & \$35

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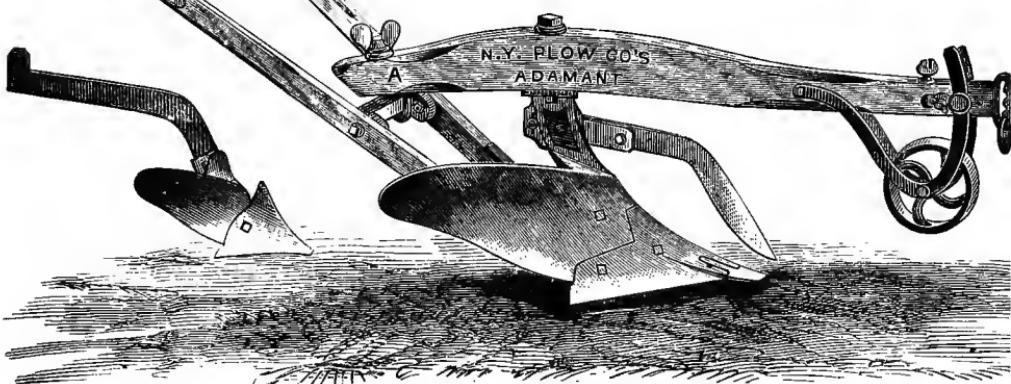
THE NEW YORK PLOW COMPANY.

THE NEW YORK PLOW CO., 55 BEEKMAN ST.,

THE NEW YORK PLOW CO.'S ADAMANT PLOWS.

ADAMANT A.

Two-Horse.



HARD METAL,
ADJUSTABLE BEAMS. BALANCED CENTRAL DRAFT,

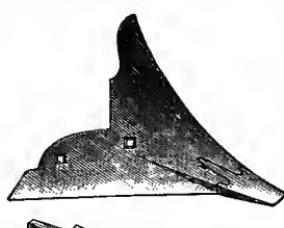
EXCELLING IN

Scouring Qualities, Lightness of Draft, and Perfect-Fitting Repairs.

THE WORD ADAMANT CLAIMED AS A TRADE MARK.

THE METAL of which they are made is of uniform hardness—so HARD that it CANNOT BE DRILLED OR FILED—SO FINE in GRAIN that it will polish like a mirror. The polished surface of the mold-board will not roughen any more than glass. Rust does not eat into it; and when coated with rust it will repolish in the ground in two minutes as bright as silver. One mold-board of this metal will wear at least as long as three of steel. The hardness of this metal causes these plows to draw much easier than ordinary cast-iron or steel plows. The metal is uniform, and not liable to soft spots, as chilled plows always are; a piece suspended rings like a bell.

We have abundant testimony that this metal will clear itself in soil where some steel plows will not work at all.



The Beam is placed in the MIDDLE OF THE WORK, giving the plow a CENTRAL DRAFT, and avoiding all underneath and side friction. This is also desirable for one-horse plows, as it permits the horse to walk in the furrow. The beam being movable at the points of attachment, the central draft can always be kept perfect. The adjusting is done at the heel of the beam, which can be moved from or to the land, as desired, which brings the work under exact control of the plowman. Even if the beam warps or springs, he can correct it. This adjustment is a great advantage in plowing among trees and through rows of corn.

REVERSIBLE SELF-SHARPENING SLIP SHARE.—We have fitted these Shares to all sizes of our Adamant Plows, reducing the cost of repairs. With a sharp point all the time, these Plows always run level and true. These Slips are held

firmly in place by a nail. Restoring the length of point causes edge of wing of the share to wear sharp, and one share will wear four or more slips which are always sharp being reversed.

We also send a solid Share, as being Stronger in Stony or Rooty Ground.

ADAMANT A is a **FULL TWO-HORSE PLOW**, suitable for both **SOD** and **STUBBLE** ground, and for both **SMOOTH** and **STONY LAND**. It is sufficiently strong for an ox-team or for three horses. It makes a furrow 14 to 15 inches wide by 6 to 8 deep. Height under beam, 17 $\frac{1}{2}$ inches.

" **S** is same size as **A**, but of a shape made especially for very sticky soils. It is suitable for prairie or other sticky lands. It is our latest and best **Wood Beam PLOW**.

" **T** is a **TWO-HORSE PLOW** of exceedingly light draft, furrow 6 to 7 inches deep, 12 to 13 inches wide, and is our best **PLOW** for light soil.

" **B** is a very **LIGHT TWO-HORSE PLOW** suitable for land entirely free from stones. 6 by 12 $\frac{1}{2}$ inch furrow.

" **C** is a **STRONG ONE-HORSE or SMALL TWO-HORSE PLOW**. Furrow 5 to 6 inch by 11 to 12 inch furrow, similar in shape to **A**.

" **E** is an **EXCELLENT ONE-HORSE PLOW**. As this size is generally used in moist soil, it will be found a great comfort by the manner in which it clears itself.

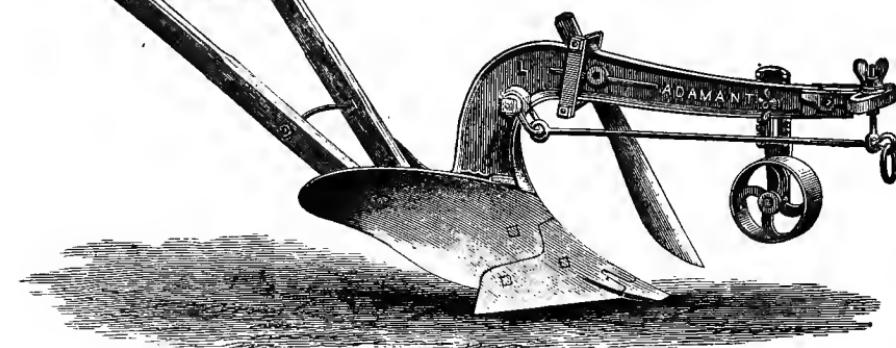
" **K** and **M** are left-hand **Plows**, same size as **A** and **B**.

" **G** is an **IRON BEAM TWO-HORSE PLOW**, and is especially adapted for burying all trash with use of **Skim PLOW** in place of **Coulter**; but any of these **Plows** will do as good work with **Coulter** as other modern **Plows** will with **Skim** or **Jointer**, because the shape of the mold is so perfect. Furrow 14 to 15 $\frac{1}{2}$ by 5 to 7 inches deep. **L** is similar to **G**, but the latter is better for **Jointer**. For very stony ground we recommend solid shares instead of **slip shares**, as less liable to accident.

" **CABBAGE or CORN** is a **PLOW** needed by every **Ensilagist** to make his stalks grow high.

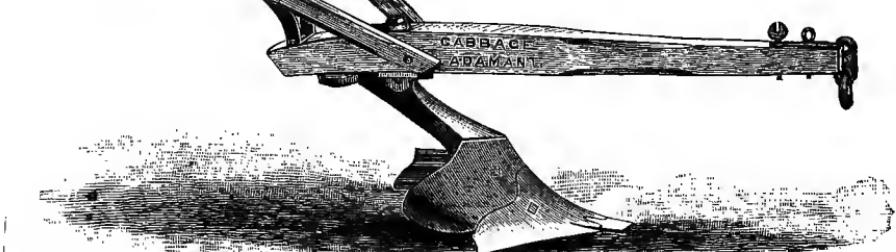
ADAMANT L.

Two-Horse Iron Beam.

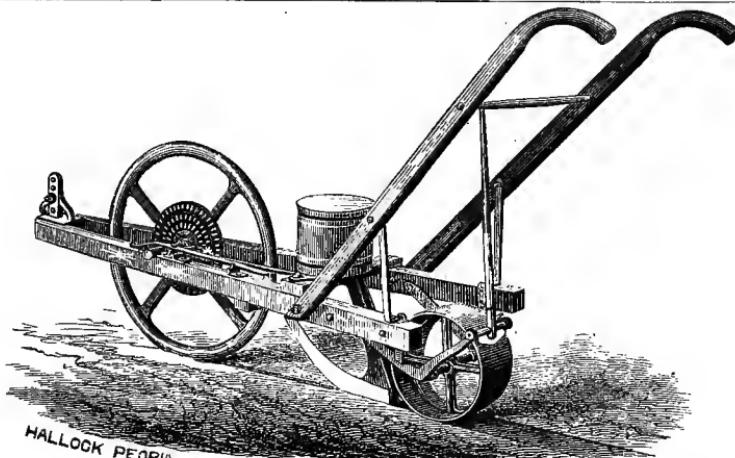


**Adamant Cabbage Plow,
or Corn Sub-Soiler.**

WITH TWO SIZE MOULDS.



PRICE OF ADAMANT PLOWS AND FIXTURES.	Plain Plow.	Plow with Wheel.	Plow with Coulter, or Skim.	Plow with Wheel & Coulter, or Skim.
ADAMANT H, Light One-Horse.....	\$5 00	....	....	....
" E, Medium "	6 00	....	....	....
" C, Full. " "	7 50	....	....	....
" B, Light Two-Horse.....	10 00	\$11 00	\$11 50	\$12 00
" T, Medium "	11 00	12 00	13 00	14 00
" A, Full "	12 00	13 00	14 00	15 00
" M, Light " Left-Hand	10 00	11 00	11 50	12 00
" K, Full " "	12 00	13 00	14 00	15 00
" G or L, Two-Horse, Iron Beam, Right-Hand	12 00	13 00	14 00	15 00
" S, Two-Horse, Wood Beam, Right-Hand, for sticky soil.....	12 00	13 00	14 00	15 00
" Cabbage, One-Horse.....	6 00	....	....	....



HALLOCK PEORIA

ENSILAGE CORN PLANTER.

The latest improved One-Horse Machine for the purpose. It opens the drill, drops the seed accurately and covers it. Price \$20.00



CHICAGO ENGR.

TWO-HORSE ROTARY CHECK ROWING CORN PLANTER,
Combines Drill and Hill Planter in same machine, two rows at a time..... \$50 00

MANURE SPREADER,

Pulverizer and Cart combined.	\$110 00
DISK HARROW <i>Latest and Best Kind.</i>	25 00
SMOOTHING HARROW	20 00

SEND FOR SPECIAL CATALOGUE.

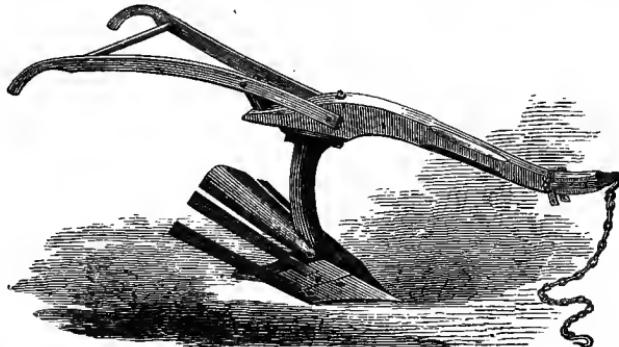
We also manufacture **PLOWS** of all kinds for different soils, and for every kind of use. Repairs for same, including Iron and Wood Beam—18, 18½, 19, 19½, 20, 21, 22, 23, 25, 35, 35½, 36, 37, 2½ D, 3½ D, 6 Road, Side Hill, Minor & Horton, and Boston, Double Mould, Eagle, Double Point, Rough and Ready, Contractors', and Grading, for both domestic and export trade.

Also—Plows for Southern States. Louisville, Richmond, Fredericksburgh and other Southern Steel and Iron Plows. Repairs for all cast plows, wherever made.

Also—Road Scrapers, Harrows, Store Trucks, Stable Furniture, Clod Crusher, Cider Mills and Presses, Press Screws, Field and Garden Rollers, Road Rollers, Corn Shellers, Corn Mills, Dog Powers, Caldrons, Farmers' Boilers, Water Drawers, Settees, Lawn Mowers, Hose Reels.

CORRESPONDENCE WITH FARMERS DESIRED.

New York Potato Digger with Steel Wings.



Price, Wood Beam, \$12.00. / Iron Beam, \$8.00.

FARM ENGINES,

These will be largely required in connection with Ensilage Cutters. The best one that we now know of in regard to economy in fuel and water, and safety from sparks (without screen), and freedom from encrustation and danger of burning tubes and crown sheets, is one with horizontal tubes, and which we can furnish as follows:

Six-Horse, Mounted.....	\$800 00
Ten-Horse, ".....	950 00

including Balanced Valve, Governor, Safety Valve, Feed Water Heater, Direct Acting Pump, Whistle, Water Gauge, Wagon Brake, Blower and Exhaust Nozzle. Weight of Ten-Horse, 3,800 lbs. Easily taken apart.

Should any satisfactory machine be offered at less price, we shall be prepared to advise farmers on the subject.

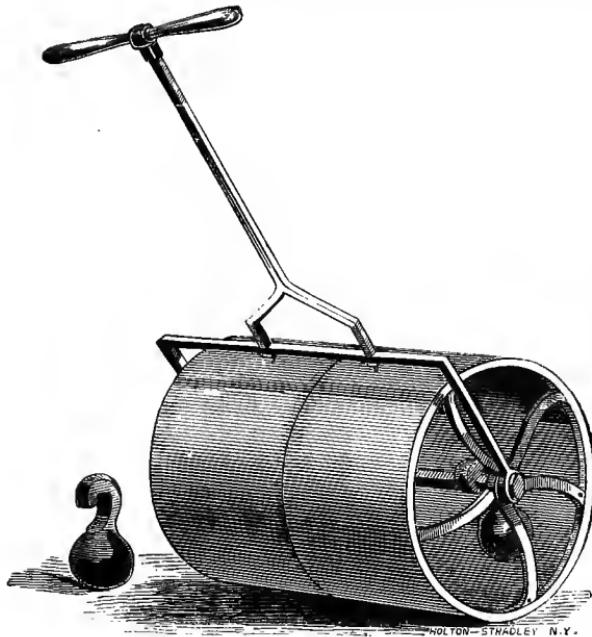
HORSE POWERS.

Two-Horse Endless Chain.....	\$150 00	Four-Horse Lever.....	\$125 00
One-Horse ".....	115 00	One-Horse Lever.....	50 00

Dog Power..... \$20 00

POTATO DIGGING MACHINE.

Will dig ten acres per day..... \$75 00



Garden Rollers.

WEIGHTS KEEP HANDLE ERECT.

2 Sec. 7½ in. face, 15 in. diameter, with weights, about	125 lbs.	\$ 8 00
1 " 12 " 20 "	140 "	10 00
1 " 20 " 20 "	250 "	14 00
2 " 12 " 20 "	300 "	18 00
3 " 12 " 20 "	450 "	25 00
1 " 12 " 24 "	200 "	13 00
2 " 12 " 24 "	400 "	22 00
1 " 12 " 28 "	250 "	16 00
2 " 12 " 28 "	500 "	26 00
3 " 12 " 28 "	700 "	40 00



THE FIELD ROLLER.

Is a valuable Machine for crushing sods and lumps remaining after the harrow has passed, pressing down stones and rendering the field smooth for the mowing machine, etc. By pressing the earth close about the seed, a more sure and quick germination is effected. This Iron Roller is the most approved kind, as it clears better and is more durable than the Wooden Roller. The stone-box is convenient for taking off loose stones. By rolling early in the spring the heaving effect of frost is repressed. Made extra heavy for Road Rolling, when so ordered, at proportionate prices.

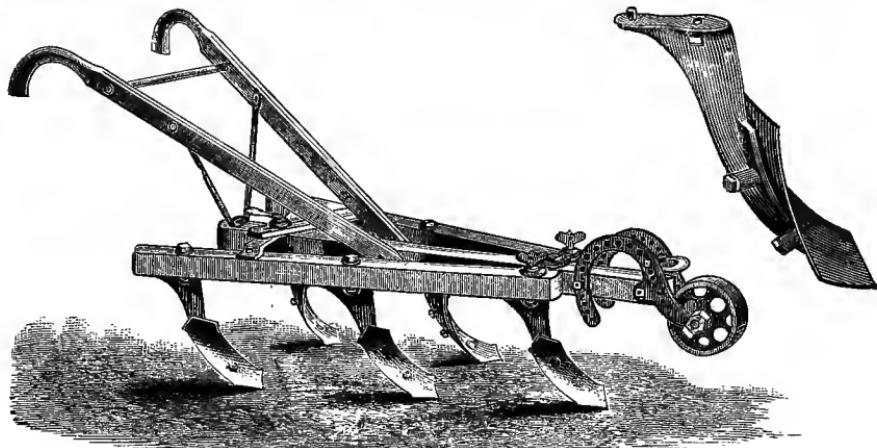
3 Sections, 12 inches face, by 20 inches diameter, weight about	550 lbs.
4 " 12 " 20 "	650 "
5 " 12 " 20 "	750 "
4 " 12 " 24 "	850 "
5 " 12 " 24 "	1000 "
6 " 12 " 24 "	1200 "
4 " 12 " 28 "	950 "
5 " 12 " 28 "	1150 "
6 " 12 " 28 "	1350 "
4 " 12 " 36 "	1400 "
5 " 12 " 36 "	1700 "
6 " 12 " 36 "	2000 "

With Whiffletrees, \$4 00 extra.

HILLING CULTIVATOR.

TOLLEY'S PATENT SCREW BLADE.

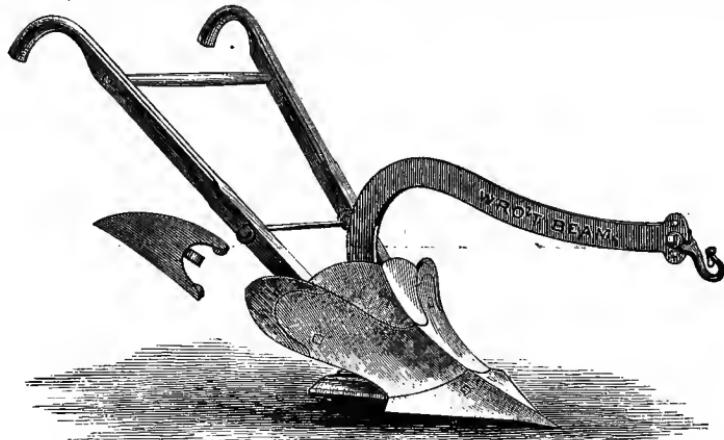
For Cultivating Corn, Potatoes, Tobacco, Sugar Cane and all Rowed Crops.



With this Cultivator the earth can be thrown **to or from the plants**, as desired, by merely changing the side bars without removing the teeth; this can be done in the field. The steel plates are reversible; they are twisted into a regular spiral curve, and will pulverize the soil and cut the weeds and grass more effectually and with less draft than any other form of cultivator plate, and at same time hill up the rows as much as may be desired, thus dispensing entirely with the use of the plow and hoe.

By the use of this cultivator a farmer can save one-half his time in cultivating a corn crop with better results than can be accomplished with a plow, and it will save him at least ten miles walking in a day. It expands to 28 inches.

Wrought Beam Double Mold Plow with Shoe.

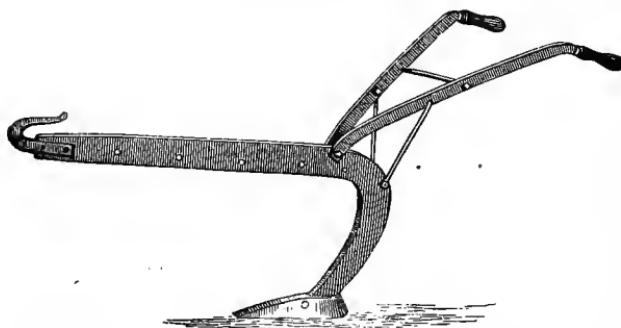


For Cultivating, and Riddging or Hilling Corn, Potatoes, etc. Holds easy, runs steady and is not liable to clog. Works different widths of rows by using long and short wings. The Centre Piece increases or diminishes the height of the Mold-board as desired.

THE GOODALL SUB-SOIL PLOW.

THE ONLY SUB-SOIL PLOW THAT CANNOT BE BROKEN.

Grub-Hook, Stone and Root Puller.

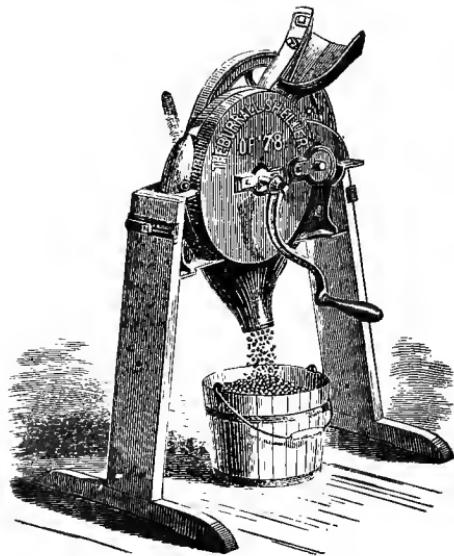


bottom of ditches or drains, by attaching a short chain. By removing the share it becomes a Grub Hook. All farmers on old farms need this Plow.

Price, - - - - \$10.00.

THE BURRALL CORN-SHELTER OF 1880.

WROUGHT SHAFTS, RIGHT HAND.

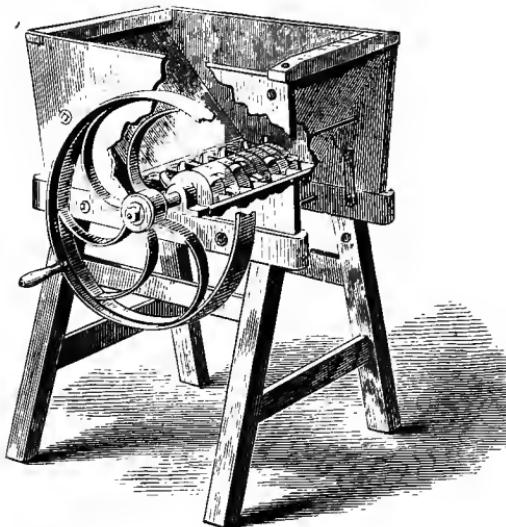


THIS SHELTER separates the COBS from the SHELLLED CORN. It has Wooden (instead of Iron) Legs, which are not liable to break, and are more easily repaired when broken.

The open front Hepper makes it Right-Handed. Wrought Shafts. Excellent Spring. Runs smooth and easy. Longer Legs, which make Sheller several inches higher than formerly. Flat Balance Wheel; can use belt if desired.

The swell at the Throat, in combination with the patented Spring-plate, admits larger ears without clogging and without scraping or breaking the cob. It shells clean. The gearing has been changed, making it stronger, and causing it to turn very much easier than any other Sheller in the market, and much easier than those that we made last year. The spreading of the feet causes it to stand entirely firm, and the increased weight adds much to its durability.

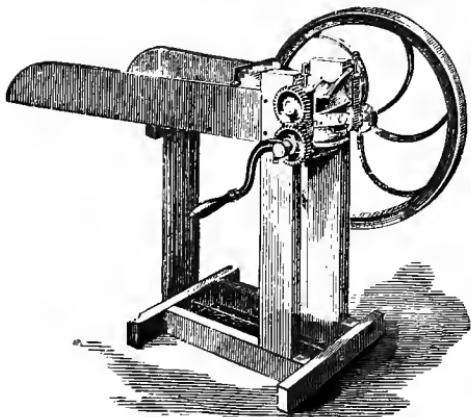
These improvements make it entirely satisfactory for every section of this country and all countries.



THE
New England Root Cutter

Is the most effective machine of the kind made. It is strong and durable, simple in its construction, and not liable to get out of order. The cylinder, or cutting apparatus, is composed of a number of hooked or flat curved teeth, which, in revolving, pass between stationary knives, and catch hold and tear to pieces the roots, etc., in small sections, for safety. Capacity about one bushel per minute.

Price, \$10.



Copper Strip Feed Cutters.

These Machines cut easier and faster than any other of like price, using hand power. The large sizes will cut faster by hand than any other cutter, without regard to price. They are easier sharpened and repaired than any other self-feeding Feed Cutter, will generally cut well from three to five years without grinding, make a clean, uniform cut, and do not clog. All parts of the machine are easily and cheaply replaced, and the knives and coppers are made so that if they are ever broken or worn out, they can, for a few cents each, be duplicated and put on for Horse Power.

The Copper does not dull the Knives and is durable.

Number of Machine.	Number of Knives.	Length of Knives. Inches.	Length of Cut. Inches.	Weight of Balance Wheel. Pounds.	Weight of Machine. Complete.	Will Cut Per Hour. Pounds.	Price of Machine. Complete.
O	3	6	3/4 and 1 1/4	14	62 lbs.	130	\$ 9 00
O 1/2	3	6	3/4 and 1 1/4	22	70 lbs.	140	10 00
A	1	8	1 1/4	42	99 lbs.	200	11 00
1	3	6	3/4 and 1 1/4	22	77 lbs.	150	11 00
2	3	6	3/4 and 1 1/4	34	85 lbs.	180	12 00
2 1/2	2	7	1 3/4 and 2 1/4	42	117 lbs.	250	15 00
3	3	6	1 1/4 and 1 3/4	42	109 lbs.	215	14 00
4	3	7	3/4 and 1 1/4	43	112 lbs.	210	15 00
5	3	7	1 1/4 and 1 3/4	52	130 lbs.	330	16 00
5 1/2	2	10	1 1/4 and 2 1/2	62	145 lbs.	410	18 00
6	3	8	1 1/2 and 1 3/4	62	140 lbs.	390	20 00
8	3	10	1 1/2 and 2	80	207 lbs.	412	30 00
9	3	12	1 1/2 and 2	80	225 lbs.	600	35 00

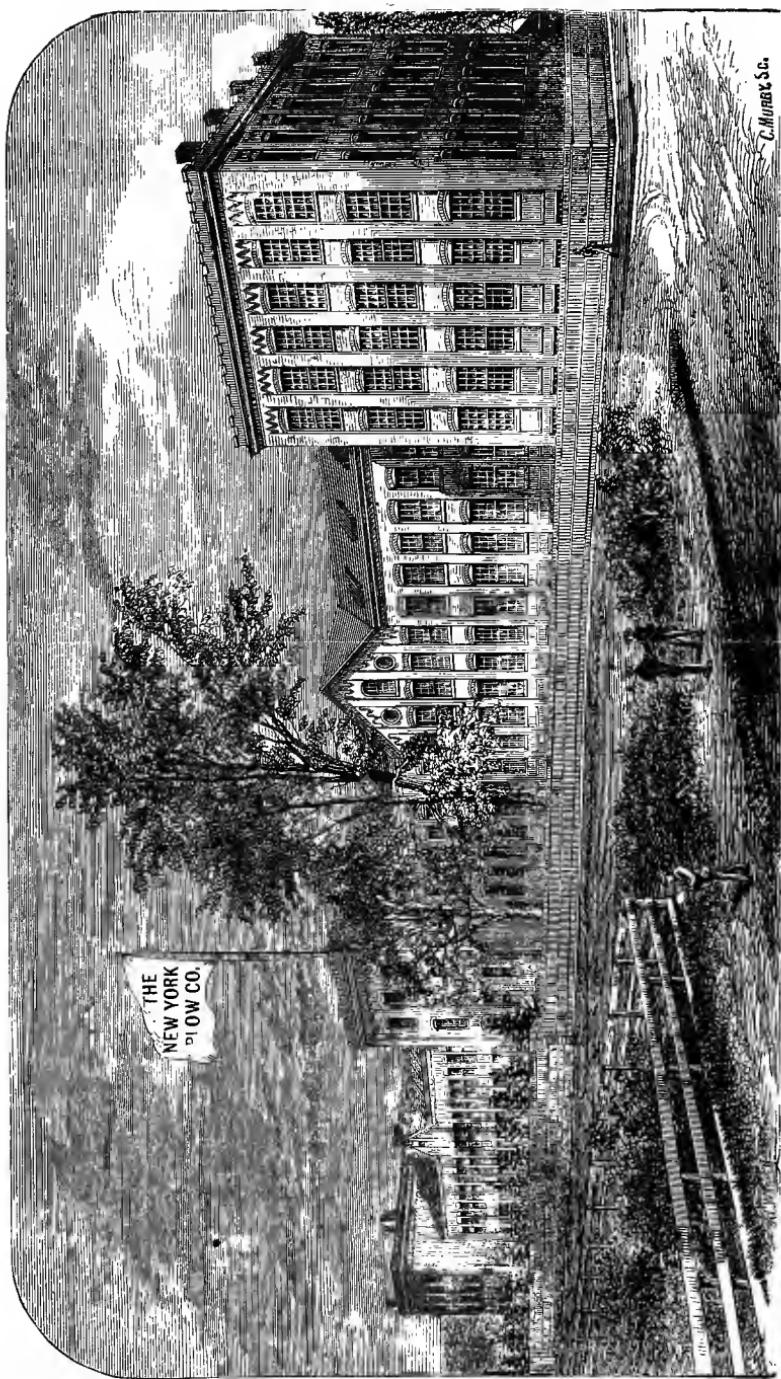
The capacity per hour in the previous table is when turned by one man at moderate speed. From three to five pounds of cut feed will make a bushel.



SOUTHERN SEED CORN,

Recommended for Ensilage.

This corn makes abundance of foliage and is very sweet. It does not mature the grain in the Northern States, but reaches full height and tassels. We furnish it by the bushel, without any fancy price, according to the market.



THE WORKS OF THE NEW YORK PLOW COMPANY.

The Main Building is 400 feet in length (containing one quarter of a mile of floor), heated by steam, with steam elevator, gas, and water. It contains an entire outfit of new and improved Machinery and Tools for iron and wood working. In the rear of this building are two large Foundries, Forge Shops, Engine Building with 200 horse-power engine, and large storage buildings for finished goods. Our immense quantity of patterns are kept in a fire-proof building. We have many pattern-makers at work improving and adding.

WE CAN FILL ORDERS PROMPTLY.

Z. Moritz & Co.

GOODS DELIVERED AT NEW YORK.

